Riley-Badenhausen

WATER TUBE BOILERS

ECONOMIZERS — WATER COOLED FURNACES

AIR PREHEATERS — SUPER-HEATERS

RILEY STOKER CORPORATION

RILEY-BADENHAUSEN

STEAM GENERATING UNITS

WATER-TUBE BOILERS

SUPERHEATERS

INTEGRAL ECONOMIZERS

AIR PREHEATERS

WATER-COOLED FURNACES

STEEL CLAD INSULATED SETTINGS

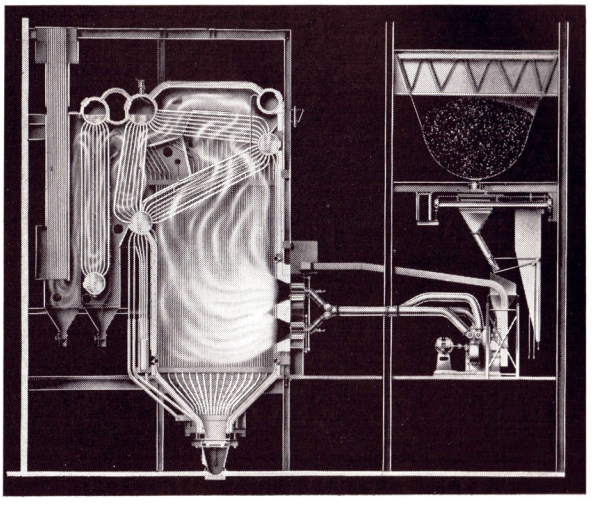
RILEY STOKER CORPORATION

WORCESTER, MASS.

BOSTON NEW YORK PHILADELPHIA PITTSBURGH BUFFALO CLEVELAND DETROIT TACOMA ST LOUIS CINCINNATI HOUSTON
CHICAGO ST PAUL KANSAS CITY LOS ANGELES JACKSON, MISS. DENVER CHARLOTTE EL PASO SALT LAKE CITY NEW ORLEANS

RILEY ENGINEERING AND SUPPLY CO., LTD., TORONTO

Riley Stoker Co., Ltd., London
Fama—France, Italy, Holland, Belgium, Switzerland, Jugo-Slavia
International Machinery Co., (W. R. Grace Co.,) South America
Feuerungsanlagen Aktiengesellschaft, Germany
Andersen-Meyer & Co., China
American Trading Co., Japan



FOR fifty-six years the Riley Stoker Corporation and subsidiaries have been serving the steam producing plants of America, Canada and foreign fields.

With accumulated experience, and manufacturing works at Worcester, Mass., Detroit, Mich., Cornwells Heights, Pa., Decatur, Ill., and Toronto, Ontario, Canada, which well equip the organization to meet present-day requirements, the Riley Stoker Corporation is now in a position to furnish

Riley-Badenhausen Steam Generators
Riley-Badenhausen Boilers
Riley-Badenhausen Economizers
Riley-Badenhausen Air Preheaters
Riley-Badenhausen Superheaters
Riley-Badenhausen Water-cooled Furnaces
Riley Atrita Unit Pulverizers
Riley Flare Type Burners
Riley Multiple Retort Stokers
Harrington Traveling Grate Stokers
Jones Underfeed Stokers

Combinations of the above equipment can be furnished, installed and placed in operation, under a single contract and with definite overall performance guarantees.

It is believed that the following pages will be of interest to those interested in the production of steam at minimum cost.

THE DAVIS PRESS WORCESTER MASS. U.S.A.

RILEY-BADENHAUSEN

HIGH CAPACITY

HIGH EFFICIENCY

STEAM GENERATING UNITS

RILEY STOKER CORPORATION

WORCESTER, MASS.

BOSTON NEW YORK PHILADELPHIA PITTSBURGH BUFFALO CLEVELAND DETROIT TACOMA ST LOUIS CINCINNATI HOUSTON
CHICAGO ST PAUL KANSAS CITY LOS ANGELES JACKSON, MISS. DENVER CHARLOTTE EL PASO SALT LAKE CITY NEW ORLEANS

RILEY ENGINEERING AND SUPPLY CO., LTD., TORONTO

Riley Stoker Co., Ltd., London
Fama—France, Italy, Holland, Belgium, Switzerland, Jugo-Slavia
International Machinery Co., (W. R. Grace Co.,) South America
Feuerungsanlagen Aktiengesellschaft, Germany
Andersen-Meyer & Co., China
American Trading Co., Japan

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS
AIR HEATERS • ECONOMIZERS • WATER-COOLED FURNACES

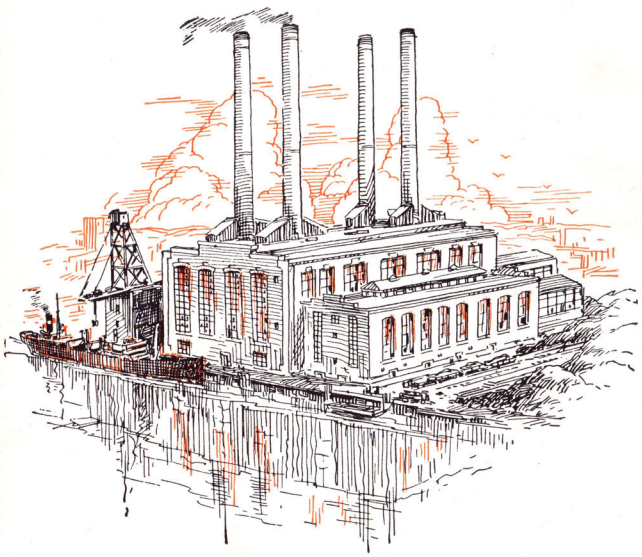
RILEY~BADENHAUSEN

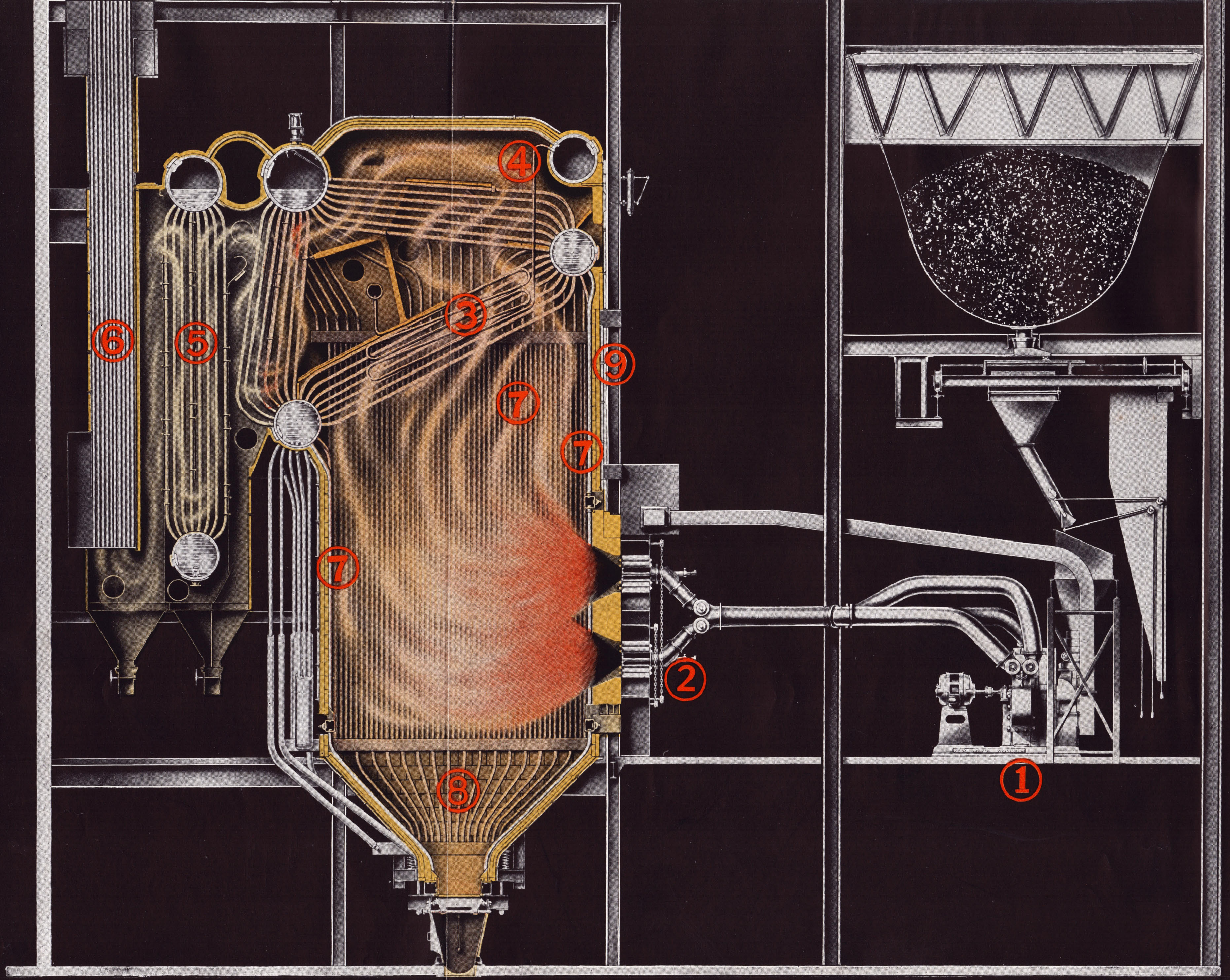
High Capacity High Efficiency

Steam Generating Units

Many installations of Riley-Badenhausen High Capacity High Efficiency Steam Generating Units have been made. The operation of these units has established the results which can be obtained with the proper design and co-ordination of the equipment involved.

You are invited to visit these installations and investigate them under actual operating conditions.





THE RILEY-BADENHAUSEN STEAM GENERATING UNIT

*1 RILEY ATRITA UNIT PULVERIZER
2 RILEY FLARE TYPE BURNER
3 RILEY-BADENHAUSEN WATER TUBE BOILER
4 RILEY-BADENHAUSEN SUPERHEATER
5 RILEY-BADENHAUSEN ECONOMIZER
6 RILEY-BADENHAUSEN AIR PREHEATER
7 RILEY-BADENHAUSEN WATER-COOLED WALLS
8 RILEY-BADENHAUSEN WATER-COOLED HOPPER BOTTOM
9 RILEY-BADENHAUSEN STEEL CLAD SETTING

*When desirable, the following fuel burning equipment may be substituted for Riley Pulverizers:
RILEY UNDERFEED — JONES SIDE-DUMP OR HARRINGTON TRAVELING GRATE STOKERS

RILEY-BADENHAUSEN

High Capacity High Efficiency Steam Generating Units

DURING recent years the increased requirement for maximum economy in generation of steam has necessitated important developments in the design of steam generating and heat recovery equipment. The requirement for maximum economy has been paralleled by a demand for greater output from the same size unit, with consequent reduction in ratio of fixed charges.

Rates of steam generation, based upon per square foot area of boiler heating surface have doubled, trebled, and in many cases quadrupled. Due to the development of design and resultant performance the old method of determining capacity of steam generating units, from boiler heating surface alone, is obviously obsolete.

Integral economizers, air preheaters and water-cooled furnaces have reached a high stage of development and their use has been generally adopted by modern steam-producing plants.

When a boiler, superheater, air preheater, economizer and water-cooled furnace are installed, steam generation is the product of the combined performance of these several related items of equipment and not the boiler alone. Obviously, the requirement for heating surface area in the boiler proper, economizer, air preheater and water-cooled furnace, is dictated by the ratio which the performance of each of these elements bears to the performance of the unit as a whole. It then follows that old ratios of steam output to simple boiler heating surface should not apply when a complete modern steam generating unit is designed.

As component parts of the complete unit the boiler, superheater, water-cooled furnace, air preheater and economizer are interdependent in their operation, and the overall performance of the complete unit is dependent upon the performance contributed by each separate element. Therefore, the efficiency of the unit as a whole is dependent upon the proper proportioning of each element as well as the proper basic design of these elements. The proportion

and relation which each separate element bears to the other elements is of necessity determined by an accurate knowledge of the performance characteristics of each element, as well as the conditions under which the complete steam generating unit will operate.

The hazards incident to placing the desired overall performance of the complete steam generating unit in the hands of several manufacturers contributing separate elements of equipment, each without an accurate knowledge of the operating characteristics of the other elements, is manifest.

The purchaser of steam generating equipment is primarily interested in obtaining a unit which will dependably produce the required quantities of steam at maximum efficiencies and with desirable operating characteristics.

Each element of the Riley-Badenhausen High Capacity High Efficiency Steam Generating Unit is designed and built as a component part of the complete unit. The design of each element is such as to make that element most effective in obtaining maximum capacity and necessary flexibility with the highest possible efficiency. The combination of these elements gives a co-ordinated, properly balanced steam generating unit. The performance of no element is compromised in favor of other elements as is sometimes the case when several manufacturers, with divergent interests, contribute to a complete unit.

The complete Riley-Badenhausen Steam Generating Unit consists of a combination of all or several of the following items of equipment:

1. Riley-Badenhausen Water Tube Boiler
2. Riley-Badenhausen Superheater
3. Riley-Badenhausen Economizer
4. Riley-Badenhausen Water-cooled Furnace
5. Riley-Badenhausen Air Preheater
6. Riley-Badenhausen Steel-clad Insulated Furnace Setting
7. Riley Fuel Burning Equipment
8. Other necessary related auxiliaries

Each of the component parts of the Riley-Badenhausen High Capacity High Efficiency Steam Generating Unit is described in the following sections of this publication.

THE DAVIS PRESS WORCESTER MASS. U.S.A.

RILEY~BADENHAUSEN

WATER-TUBE BOILERS

RILEY STOKER CORPORATION

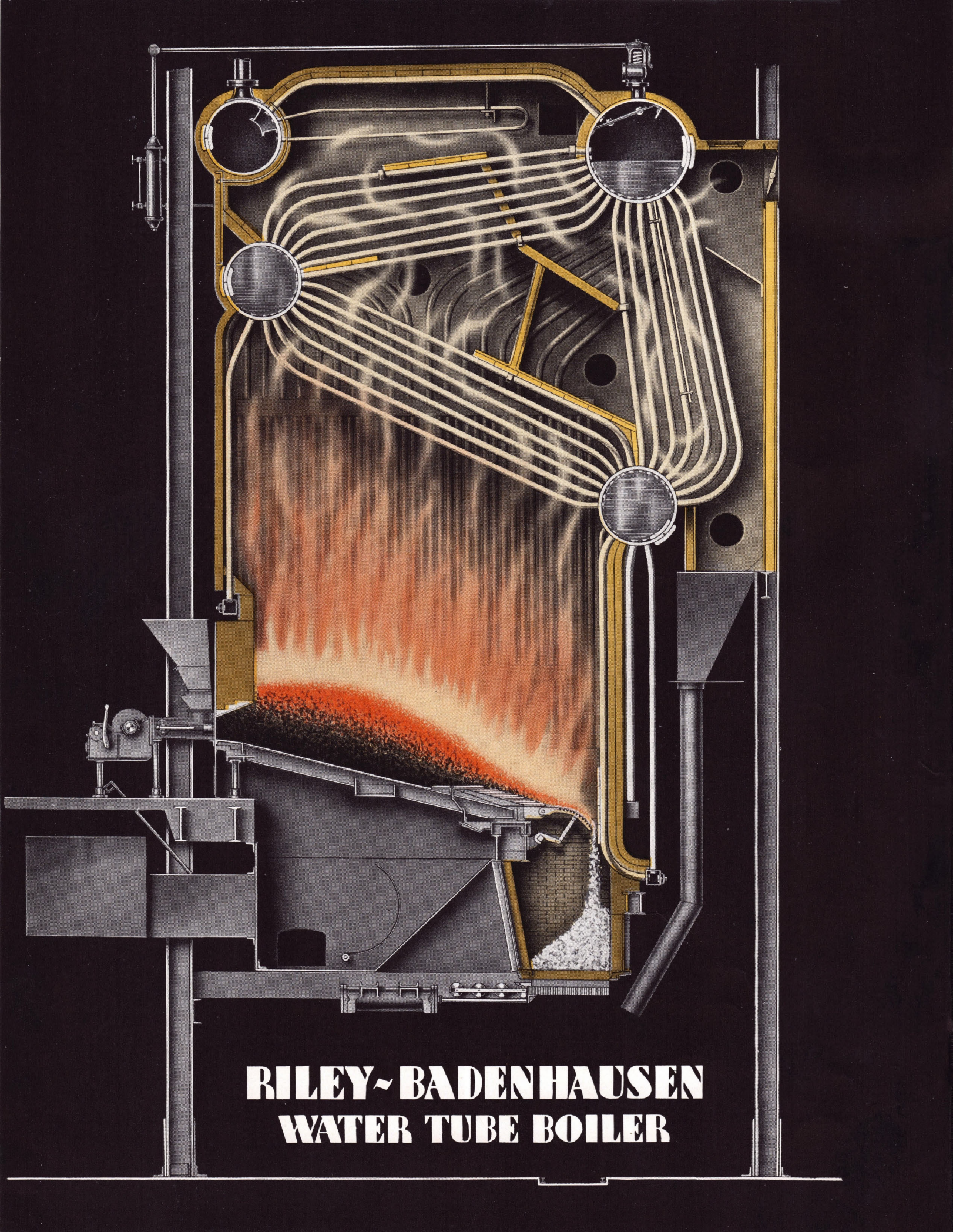
WORCESTER, MASS.

BOSTON NEW YORK PHILADELPHIA PITTSBURGH BUFFALO CLEVELAND DETROIT TACOMA ST LOUIS CINCINNATI HOUSTON
CHICAGO ST PAUL KANSAS CITY LOS ANGELES JACKSON, MISS. DENVER CHARLOTTE EL PASO SALT LAKE CITY NEW ORLEANS

RILEY ENGINEERING AND SUPPLY CO., LTD., TORONTO

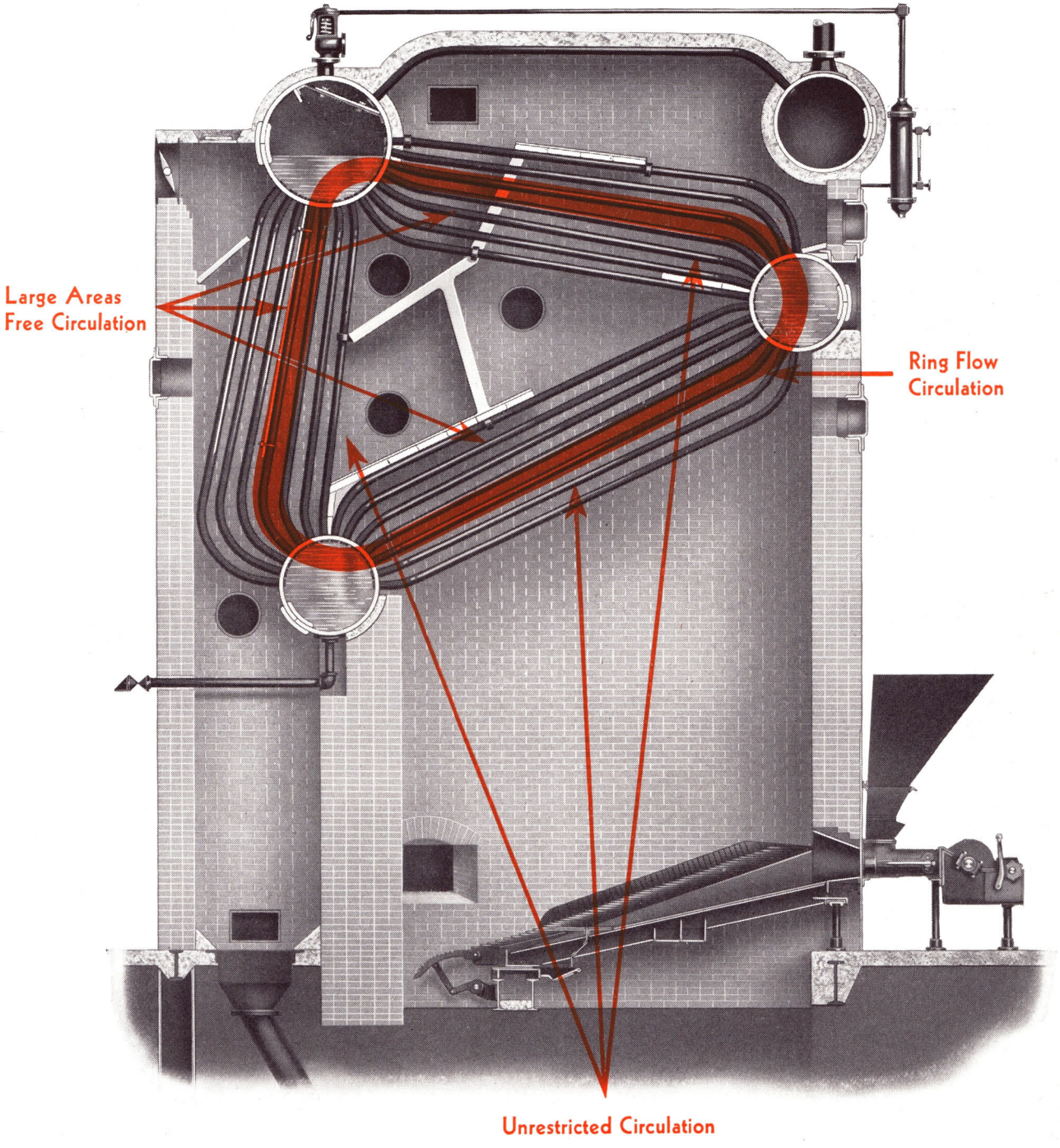
Riley Stoker Co., Ltd., London
Fama—France, Italy, Holland, Belgium, Switzerland, Jugo-Slavia
International Machinery Co., (W. R. Grace Co.,) South America
Feuerungsanlagen Aktiengesellschaft, Germany
Andersen-Meyer & Co., China
American Trading Co., Japan

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS
AIR HEATERS • ECONOMIZERS • WATER-COOLED FURNACES



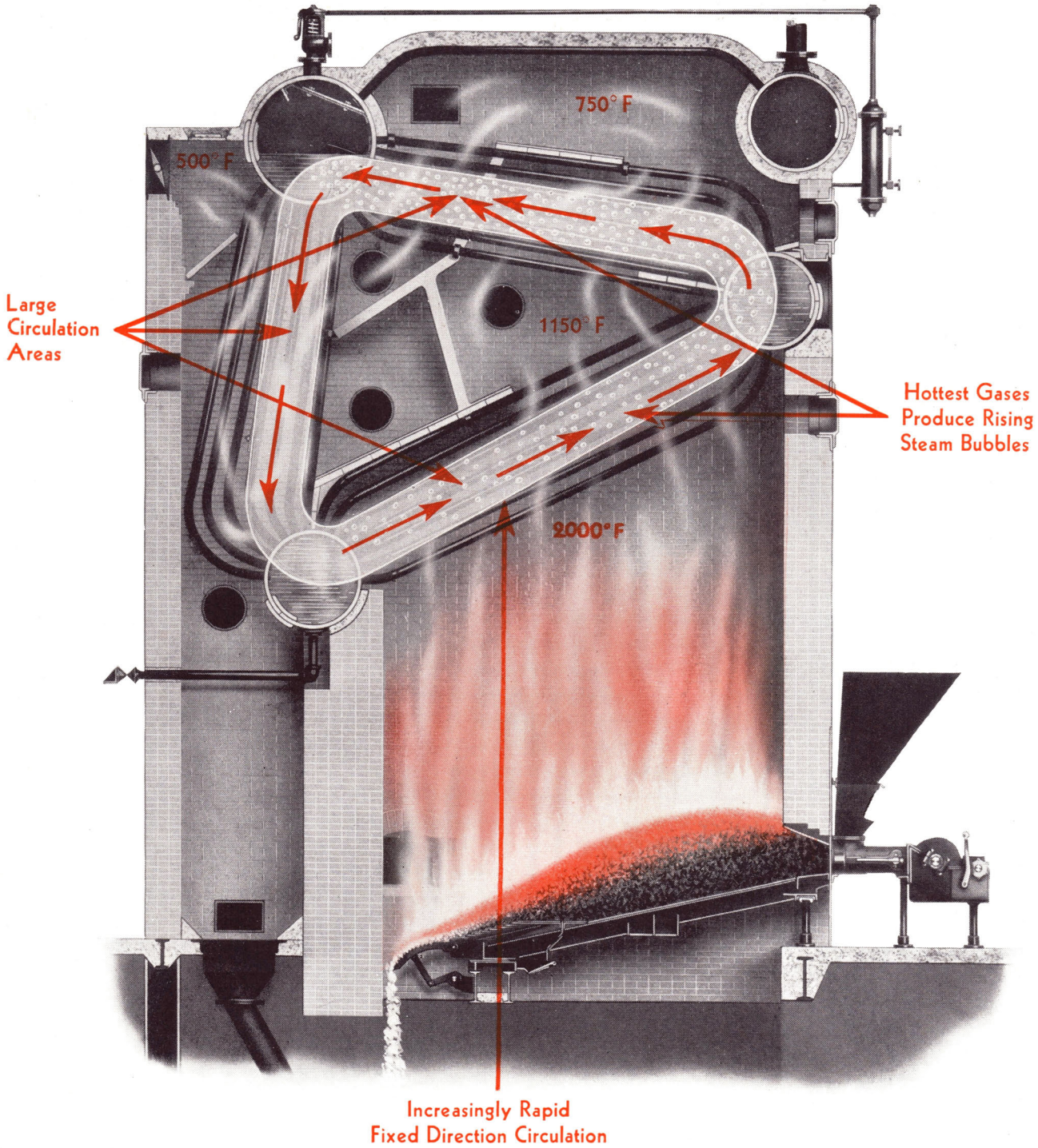
RILEY~BADENHAUSEN
WATER TUBE BOILER

Characteristics of Riley-Badenhausen Boilers



Ring Flow Circulation

The design of Riley-Badenhausen Boilers is based upon the ring flow principle of circulation. Very large water circulation areas are used through boiler tubes and drums, making possible continuous unrestricted circulation.

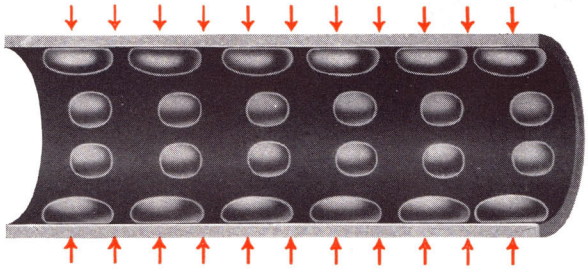


Positive Circulation

All tubes exposed to high temperatures carry upward flow of water and steam bubbles. This ensures positive circulation in a fixed direction in all of the tubes, with a very definitely increasing rate of circulation as the steam output increases.

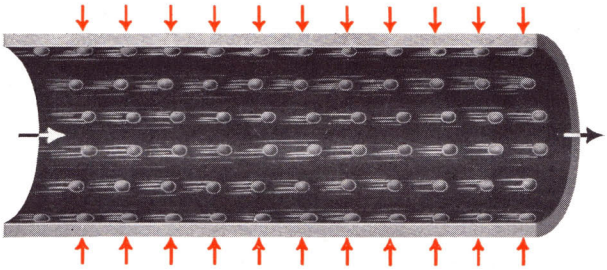
Comparison of Water Contact Surfaces in Boiler Tubes

Steam bubbles are diagramatically shown below in a tube with comparatively restricted circulation.

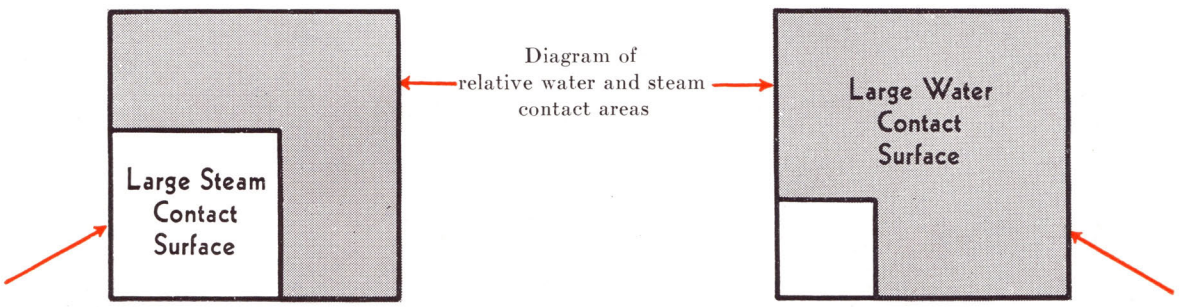


With large steam bubbles in contact with the tube, due to sluggish or indeterminate circulation, the steam contact surface is proportionately large.

Steam bubbles are diagramatically shown below in a tube where rapid circulation is maintained.



With small steam bubbles rapidly removed as formed and quickly carried to the point of liberation, the water contact surface is large.



Coefficient of heat transfer from tube to steam is low.

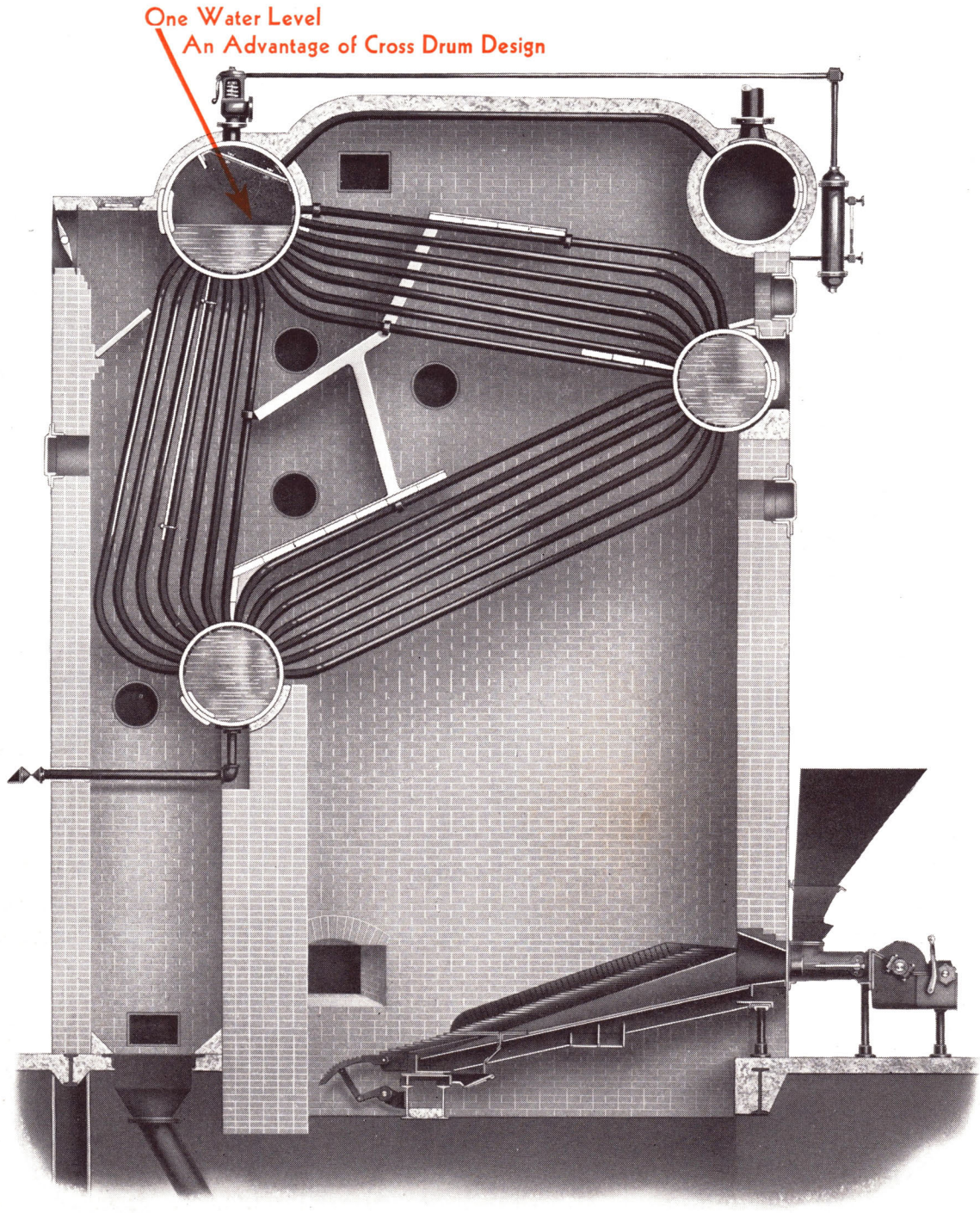
Coefficient of heat transfer from tube to water is high.

Low Flue Gas Temperatures

With properly proportioned gas passages and baffling arranged to effectively scrub all heating surfaces, *low flue gas temperatures* result in the Riley-Badenhausen Boiler because of its rapid circulation. This result is obtained, because with the consequent rapid removal of all steam bubbles as formed, water is kept in intimate contact with the steel heat transmission surfaces and maintains these surfaces at a temperature very closely approximating the water temperature.

Even at extremely high rates of evaporation, the Riley-Badenhausen Boiler has a comparatively flat flue gas temperature curve with small differential between the steam and exit gas temperatures at high ratings. Test data taken on existing Riley-Badenhausen installations prove that these boilers can be operated at very high steaming rates with excellent economy.

A further operating advantage obtained with rapid unrestricted circulation and the consequent large water contact surface, as described above, is that for a given condition of boiler water and a given rate of evaporation, the scale deposited on the tube surfaces is maintained at a minimum. This, too, is a fact proven under actual operating conditions.

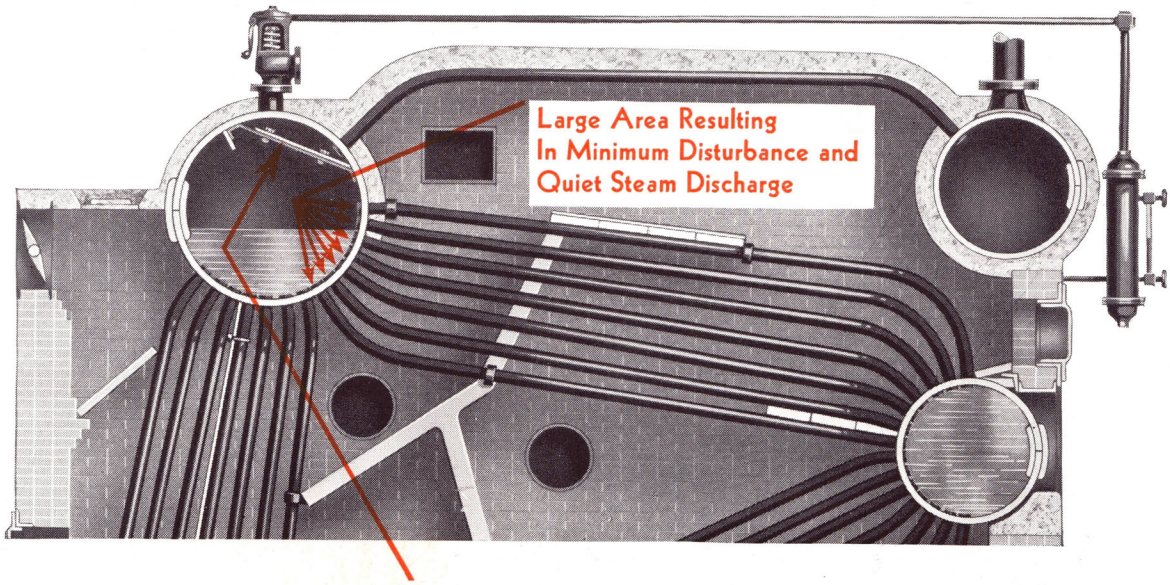


One Water Level

There is one water level, the true reading of which is indicated by the water column attached directly to the rear drum. The position of the water in the boiler is definitely established by this one water level. This predetermined level is maintained by the feed regulating device at all steaming rates.

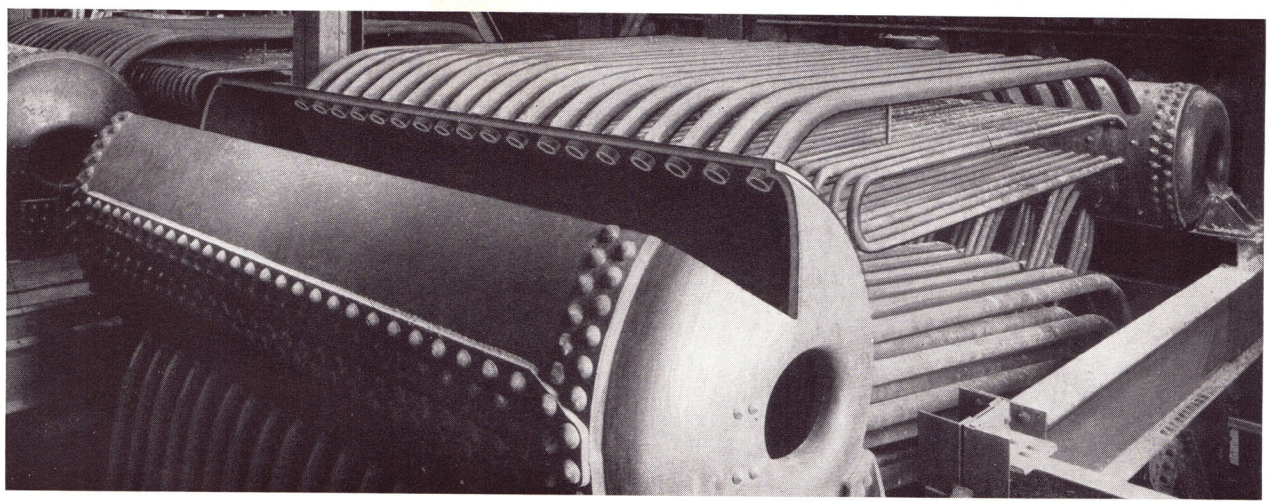
Quiet Steam Discharge

The area of the tube bank is very large at the point of issue into the steam drum, resulting in the quiet discharge of steam at this point. Consequently, a minimum entrainment of moisture occurs at the point of steam liberation.



Carefully Designed Baffle in Steam Drum

To reduce to a minimum the carry of moisture into the drying tubes, a carefully designed baffle is installed as shown.

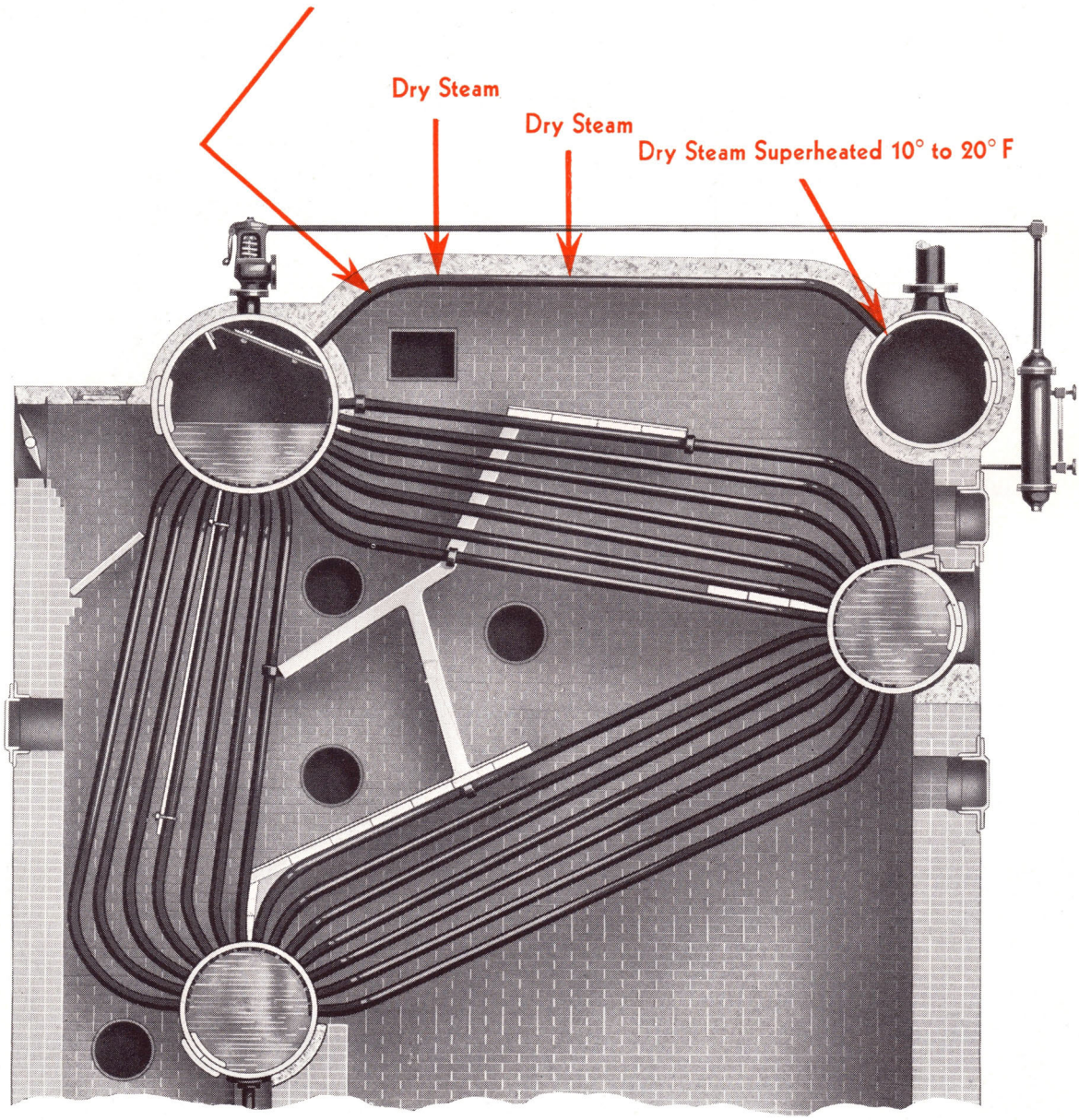


Steam Uniformly Collected

The steam is uniformly collected at low velocity by the overcomer tubes evenly spaced over the entire length of the drum. It is apparent that uniform distribution of steam to all superheater tubes also results with this design.

Dry Steam

Overcomer tubes connecting the third and fourth drums entirely remove any slight residual moisture from the steam and deliver it dry and superheated 10 to 20 degrees Fahrenheit to the fourth drum.



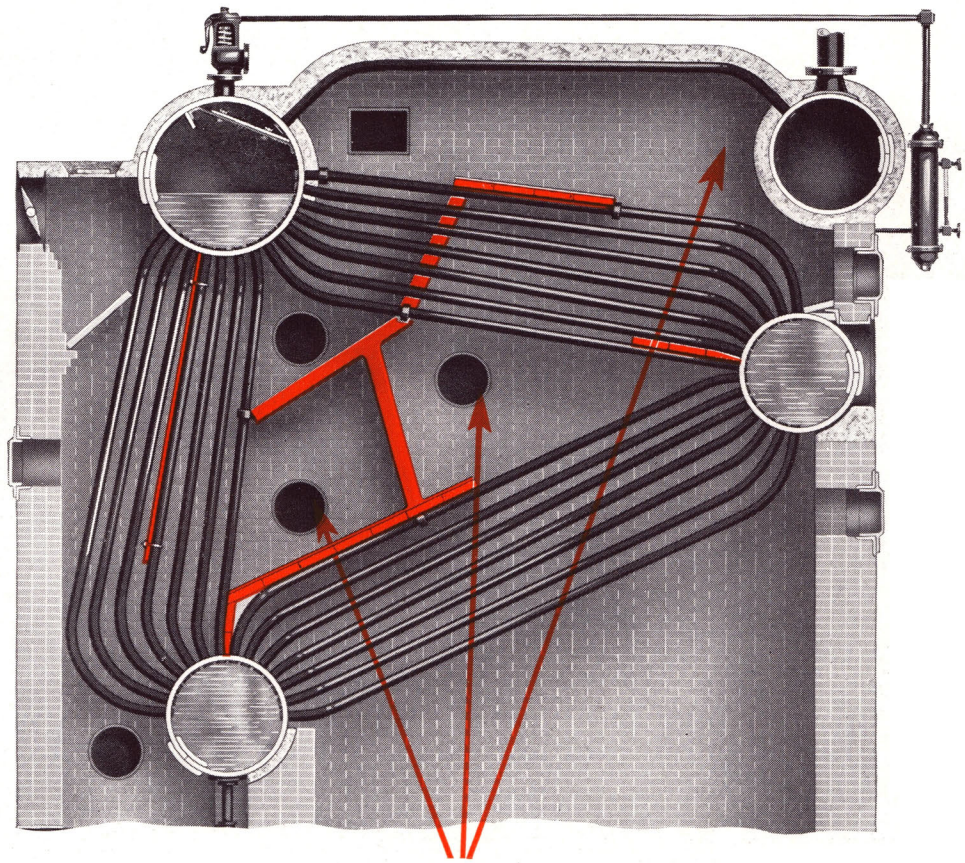
The dry steam drum, providing space for separation and collection of any solids left after evaporation of residual moisture, reduces to a minimum the carry of solids to steam lines and prime movers.

Baffle Arrangement

Baffles are arranged to assure gas distribution over all heating surfaces and to maintain a substantially constant velocity through all boiler passes. This is made possible by the adaptability of the boiler to a flexible baffle design.

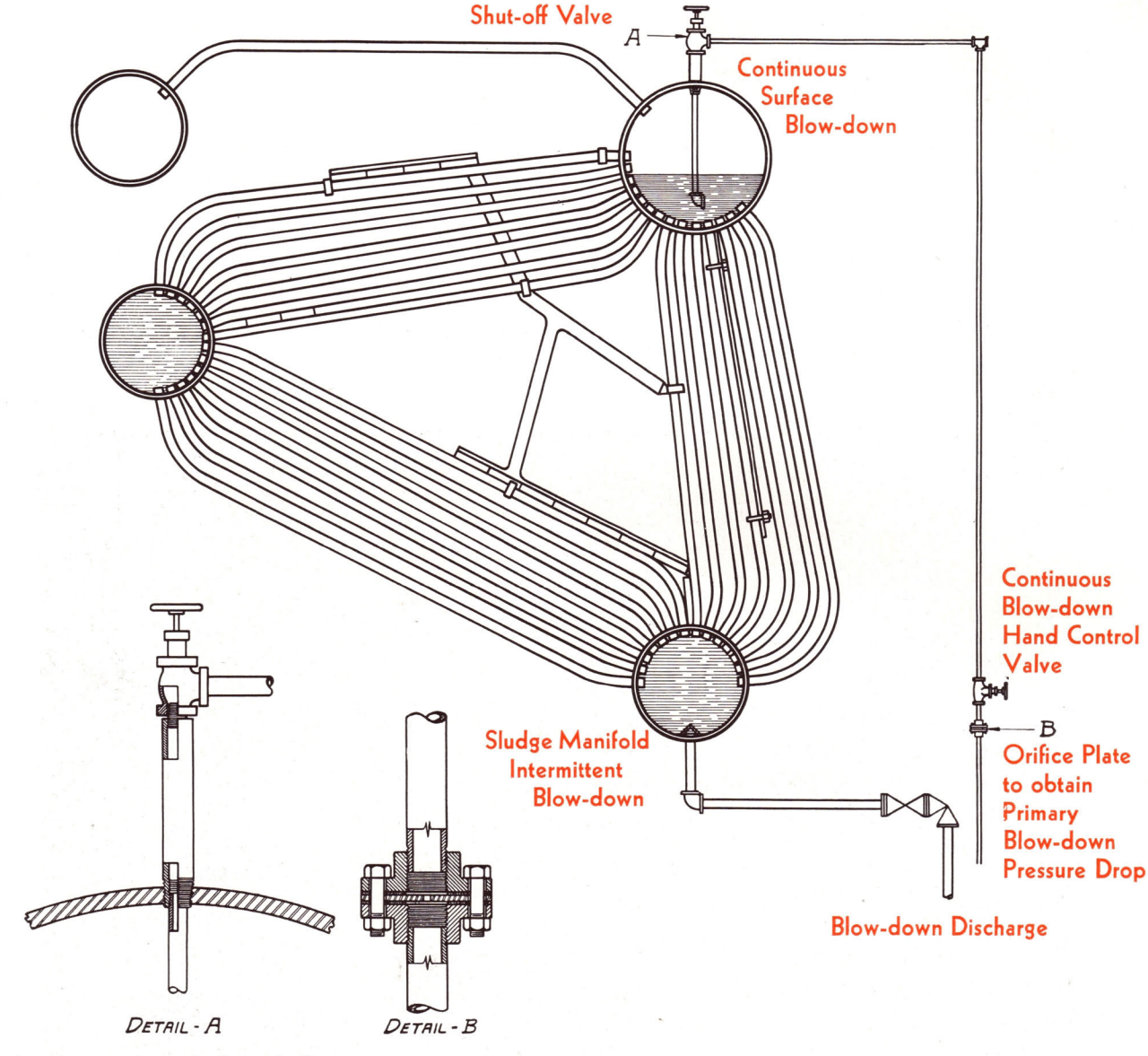
In addition to Low Exit Gas Temperatures, as previously explained, the *low draft loss* of the Riley-Badenhausen Boiler results from properly arranged and proportioned gas passages, without restrictions.

On account of its positive water circulation and arrangement of tube banks, the proper baffling of the Riley-Badenhausen Boiler makes it possible to obtain a very rapid reduction in gas temperatures in the early passes, decreasing the volume of the gas passing over the later tube areas, and proportionately maintaining the draft loss at a minimum.



Proper Accessibility to { Baffles, Soot Blowers, Heating Surfaces }

The arrangement of tube banks further provides large space between them, making all parts of the boiler heating surface readily accessible; affording ease and convenience in the installation and inspection of baffles and soot blowers.



Blow-down Connections

Continuous blow-down has been proven to be the method best adapted to the positive control of boiler water concentration.

For this reason each Riley-Badenhausen Boiler is equipped with a continuous surface blow-down connection, arrangement of which is illustrated above.

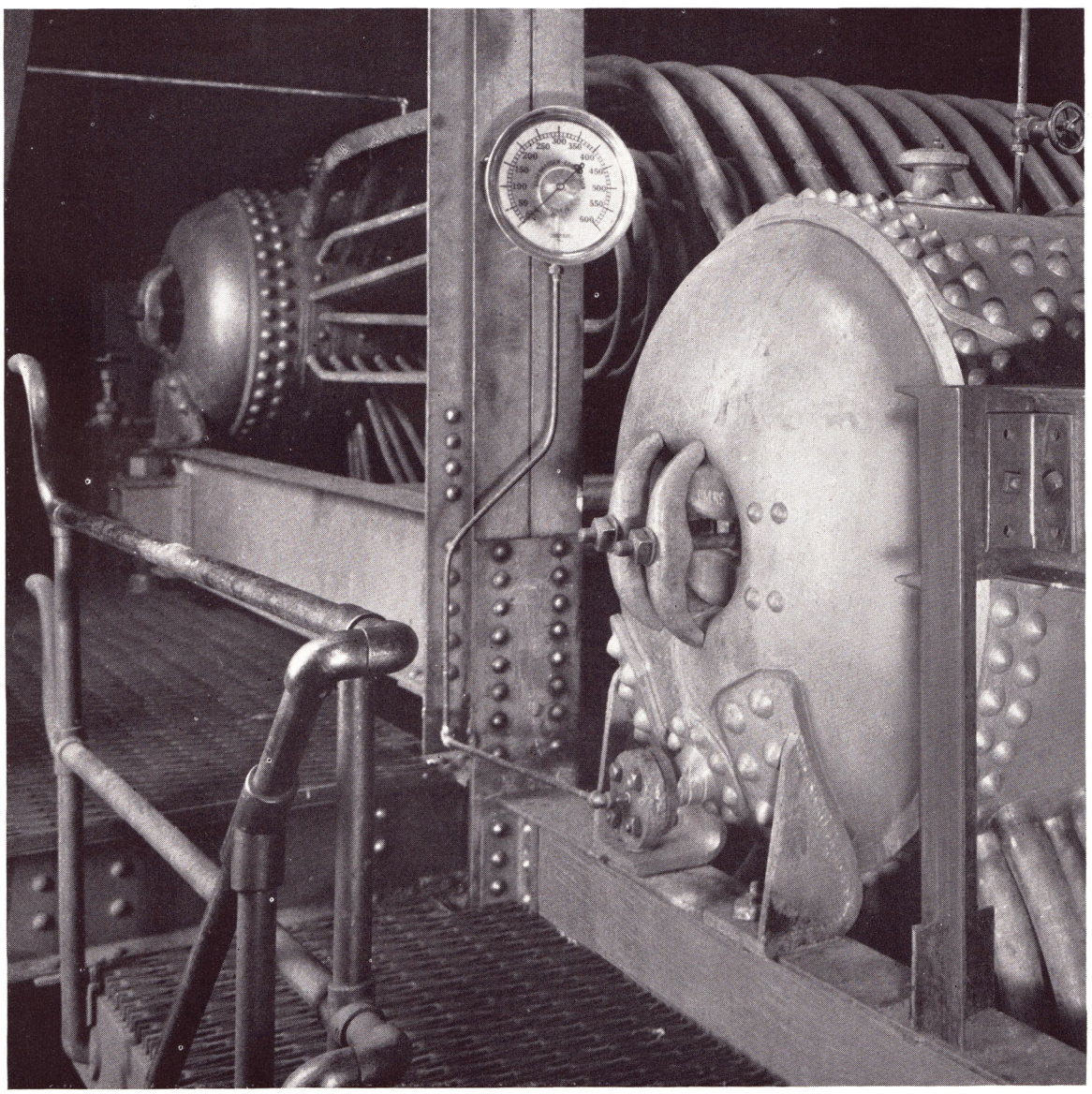
In addition, the usual bottom blow-down connection is provided with a manifold designed for the removal of sludge over the entire length of the mud drum.

Construction of Riley-Badenhausen Boilers

Only the best of workmanship and materials are used throughout in the construction of Riley-Badenhausen Boilers.

The drums, except where pressures make the use of seamless drums desirable, are riveted according to A. S. M. E. Code and State Codes requirements. All riveted drums are made in one sheet, rolled to a true circle and double butt strapped. The single longitudinal seam is in every case on the outside of the boiler away from the hot gases.

The Riley Stoker Corporation is prepared to furnish Riley-Badenhausen Boilers for any required pressure. For high pressures, seamless drums are used.

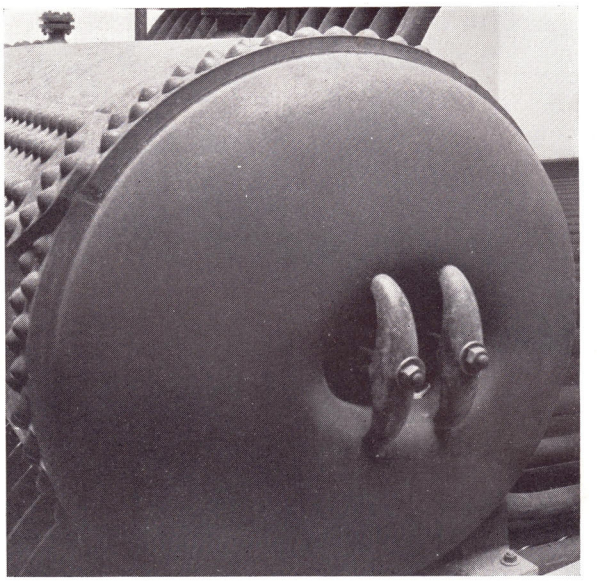


Drum Head Construction

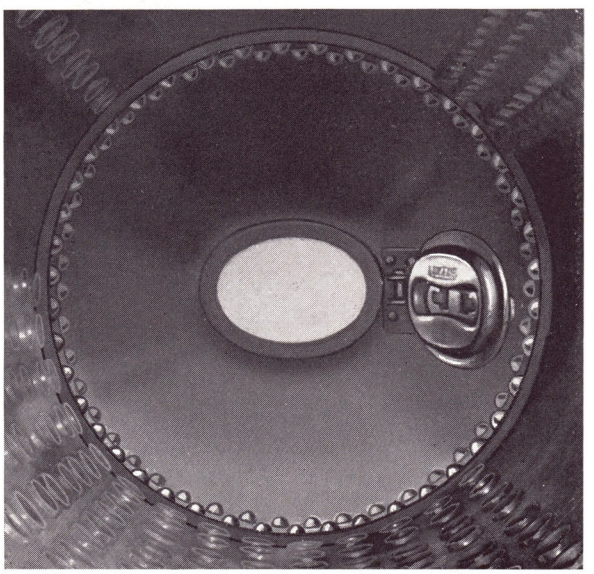
When riveted drums are used, the ends of the longitudinal seam of the drum shell are electrically welded for the proper distance before machining to receive the drum heads.

Drum heads are of the convex type. The inside surfaces of the shell are carefully machined at the ends where the heads are inserted. Each drum head is then machined on the outside of the flanges to obtain perfect metal to metal contact with the shell before rivets are driven.

A 12″ x 16″ manhole with hinged cover, as illustrated in the lower photograph, provides ready access to the drum.



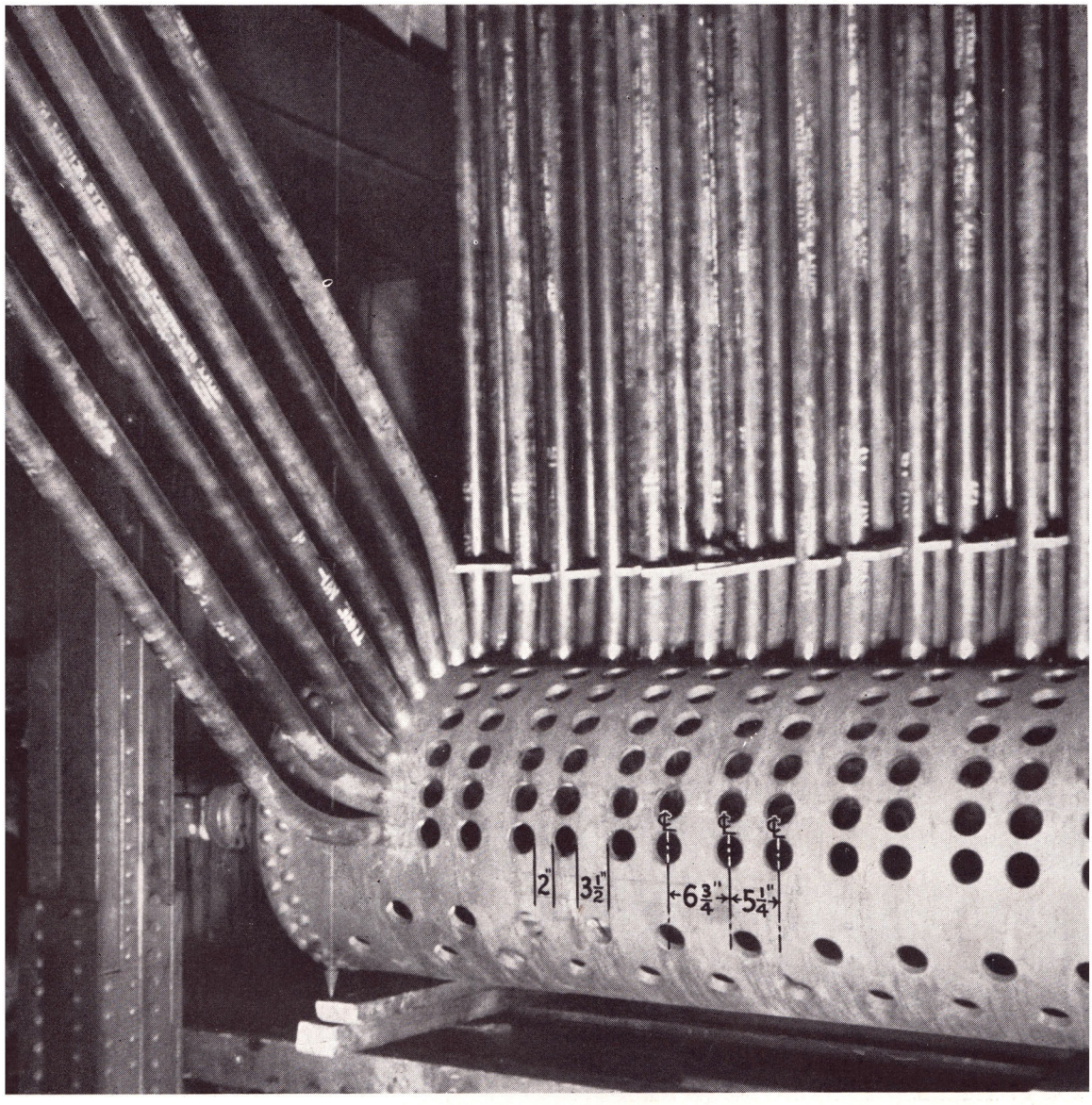
Outside View of Boiler Drum Head



Inside View of Boiler Drum Head

Boiler Nozzles

Flanged forged steel nozzles are used with Riley-Badenhausen Boilers. In the larger sizes these nozzles are the saddle type and are riveted to the drum shell. The smaller safety valve, feed and blowoff nozzles are straight neck forgings and are expanded into the shell, flared on the inside, and welded on the outside and the inside of the shell.



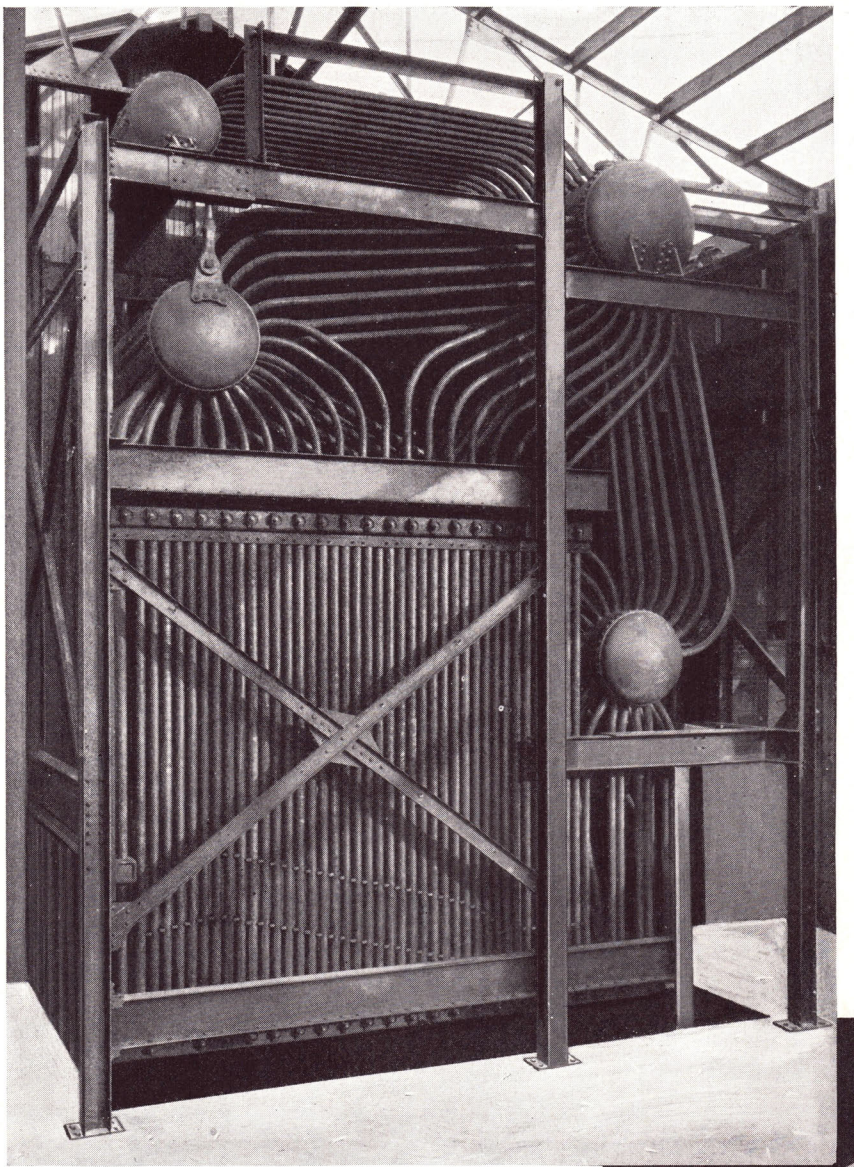
Tube Spacing

Tubes used in Riley-Badenhausen Boilers are hot rolled seamless tubes conforming to A. S. M. E. Boiler Code Specifications.

All tubes are 3¼" O.D. of the proper gauge for the operating working pressures involved.

In the tube banks 5¼" and 6¾" spacing is used in alternate rows, as shown in the photograph above. This provides an alley 3½" wide between each group of two tubes, so that any tube can be removed and replaced without disturbing any other tube.

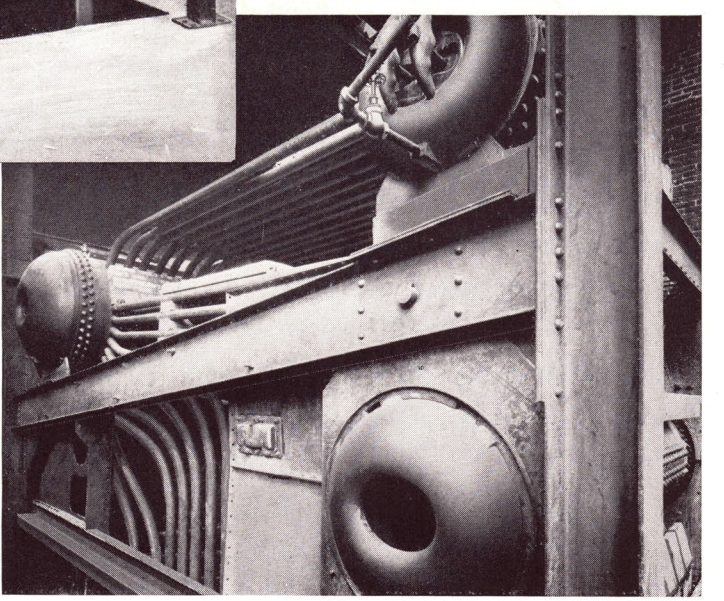
Wider tube spacing is used for high pressure work.



Method of Suspension

The boiler is entirely supported from a structural steel framework. The No. 3 drum and No. 4 drum are supported on saddles securely fastened to the supporting beams. The No. 2 drum is hung on each end from these beams by a hanger or in a ring to allow free expansion. The No. 1 drum is swung free, being supported by the tubes from the No. 2 and No. 3 drums.

This method of suspension avoids strains due to expansion and contraction of boiler under operating conditions.

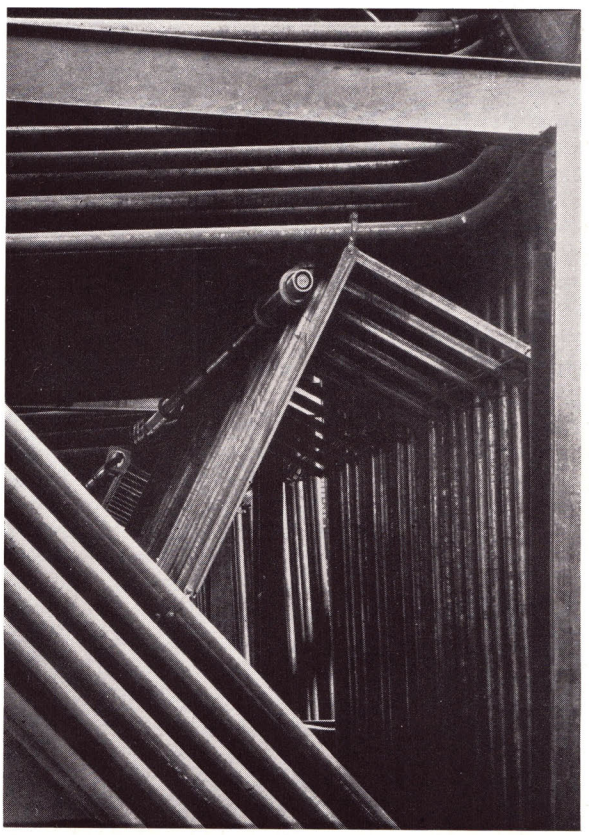


Upper illustration shows No. 2 Drum suspended from the crossbeam by a bolt and clevis hanger.

Lower illustration shows No. 2 Drum hung in a ring plate. This construction is used to carry the greater weights encountered with large size boilers.

Baffle Construction

The heavy rugged construction of the baffles used with Riley-Badenhausen Boilers assures gas tightness with long life, and a minimum of maintenance. Baffles in the high temperature zones are of tile and monolithic construction. Where the baffles are unsupported by the tube banks, they are reinforced with heavy T-bars securely clamped at each end to the boiler tubes, as shown in the accompanying photographs.

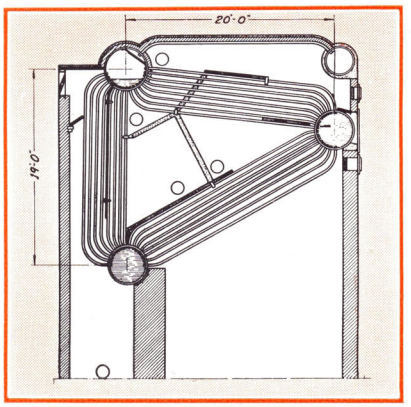


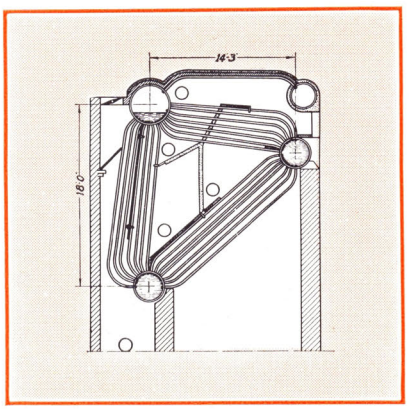
Photograph Showing Heavy T-bars
Reinforcing Baffles

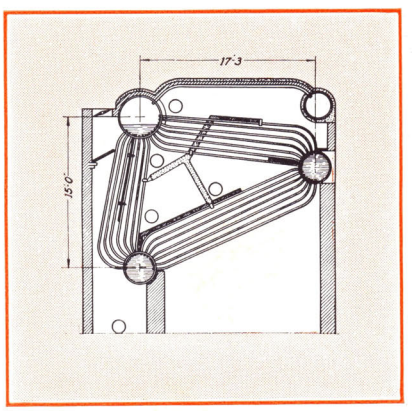
Photograph Showing Baffle Construction
Note Heavy T-bar Reinforcement

Baffle in Rear Bank

In the rear bank, where the low temperature of the gases permits, a sectional steel baffle is used. This baffle is held tightly in place by U-bolts clamped around the boiler tubes.





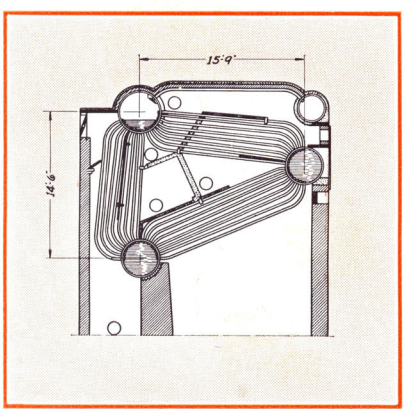


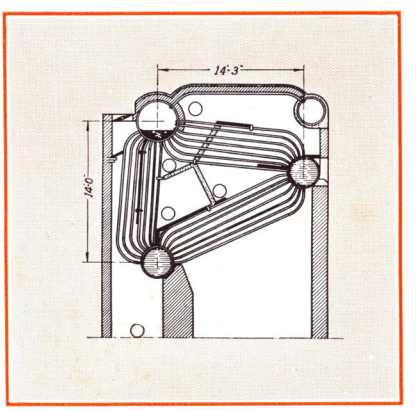
Classes of Riley-Badenhausen Boilers

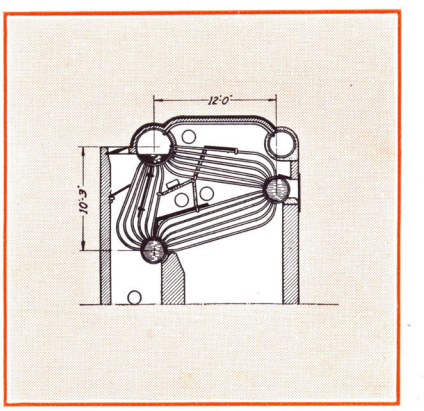
Riley-Badenhausen Boilers are available in many different classes to meet the variables of size and space limitations, as well as those of furnace dimensions required for different fuels and different types of fuel burning equipment to be used.

From the accompanying scale drawn illustrations, an idea will be obtained of the way in which the length of tube banks is varied to increase or decrease the height and depth of the boiler. The typical classes shown vary in height from 10′3″ to 19′0″ center line to center line of the upper and lower drums and in depth from 12′0″ to 20′0″ center line to center line of the front and back drums.

In addition to the above variable dimensions, the number of tubes in each bank can be slightly varied.







THE DAVIS PRESS WORCESTER MASS. U.S.A.

RILEY~BADENHAUSEN

SUPERHEATERS

RILEY STOKER CORPORATION

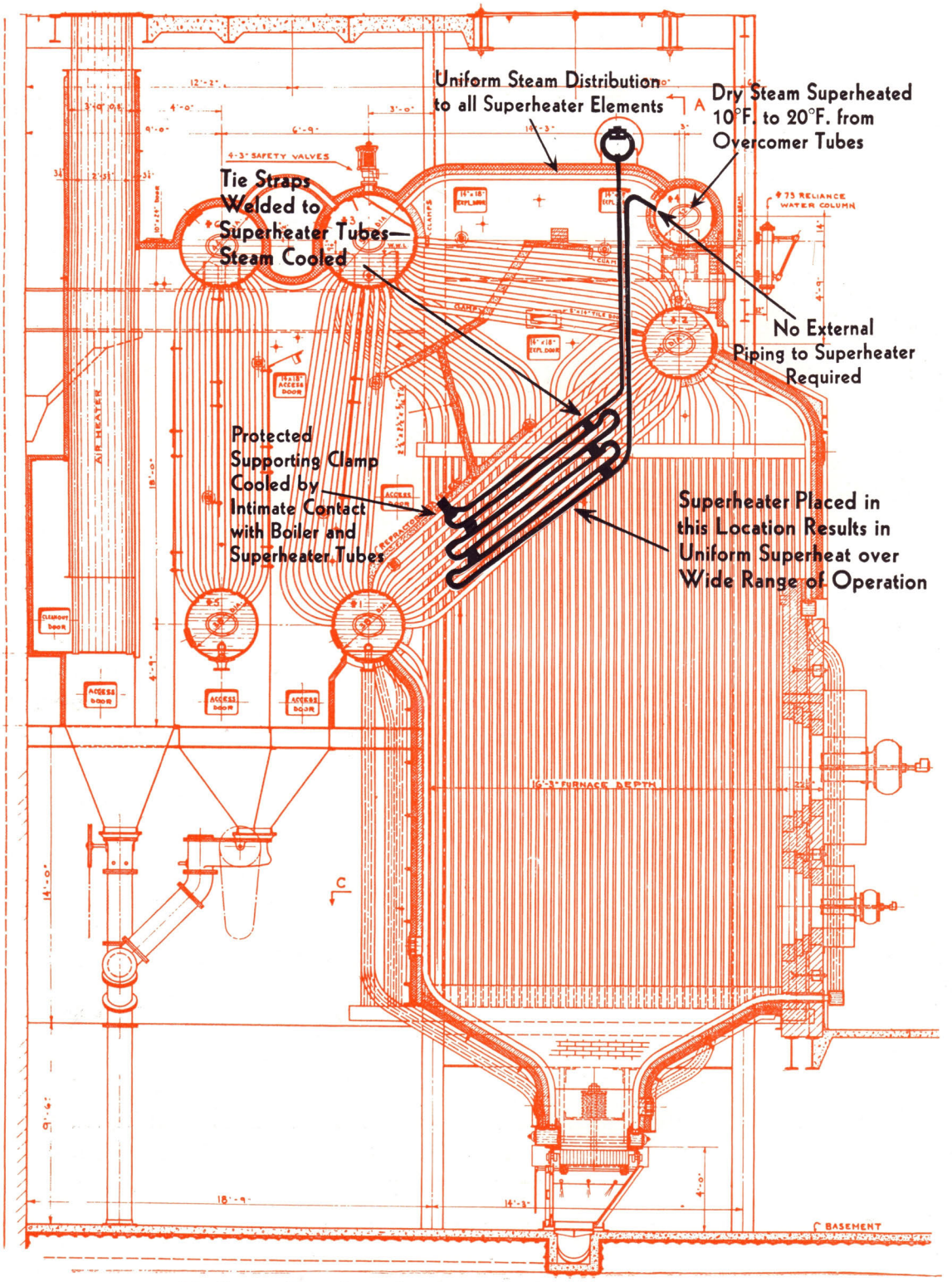
WORCESTER, MASS.

BOSTON NEW YORK PHILADELPHIA PITTSBURGH BUFFALO CLEVELAND DETROIT TACOMA ST LOUIS CINCINNATI HOUSTON
CHICAGO ST PAUL KANSAS CITY LOS ANGELES JACKSON, MISS. DENVER CHARLOTTE EL PASO SALT LAKE CITY NEW ORLEANS

RILEY ENGINEERING AND SUPPLY CO., LTD., TORONTO

Riley Stoker Co., Ltd., London
Fama—France, Italy, Holland, Belgium, Switzerland, Jugo-Slavia
International Machinery Co., (W. R. Grace Co.,) South America
Feuerungsanlagen Aktiengesellschaft, Germany
Andersen-Meyer & Co., China
American Trading Co., Japan

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS
AIR HEATERS • ECONOMIZERS • WATER-COOLED FURNACES

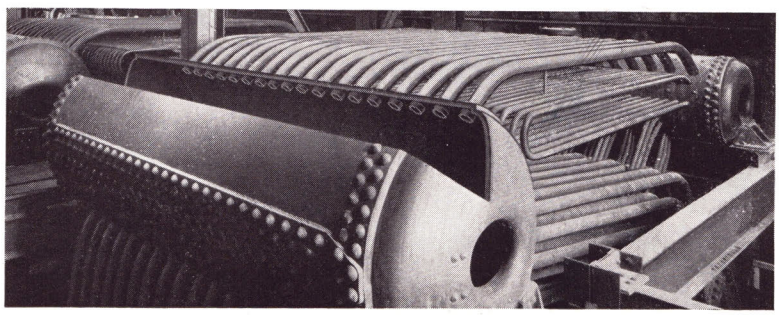

Uniform Steam Distribution to all Superheater Elements
Dry Steam Superheated 10°F. to 20°F. from Overcomer Tubes
Tie Straps Welded to Superheater Tubes—Steam Cooled
No External Piping to Superheater Required
Protected Supporting Clamp Cooled by Intimate Contact with Boiler and Superheater Tubes
Superheater Placed in this Location Results in Uniform Superheat over Wide Range of Operation
4-3" SAFETY VALVES
AIR HEATER
16'-3" FURNACE DEPTH
BASEMENT

Riley-Badenhausen Superheaters

The design of the Riley-Badenhausen Superheater is such that the superheater surfaces can be readily installed in a number of different locations relative to the boiler heating surfaces. It is accordingly possible, through the proper proportioning and location of superheater areas, to obtain any desired steam temperature. It is necessary, of course, in arranging and proportioning the superheater areas, to take into account, with other factors, the amount of water-cooled area in the furnace exposed to direct radiation, the nature of the fuel to be burned, and the excess air necessary for proper combustion.

Riley-Badenhausen Superheaters

Riley-Badenhausen Superheaters are designed and manufactured as an integral part of the Badenhausen Boiler. It is very important to note that uniform distribution of steam to all superheater tubes over the entire range of ratings is obtained by evenly spacing the overcomer and superheater tubes across the entire length of the dry steam drum. Because the steam delivered from the overcomer tubes of the Riley-Badenhausen Boiler is dry and slightly superheated, the superheater is not required to evaporate any residual moisture.



Steam is uniformly distributed to superheater tubes.

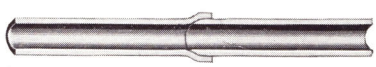
Bare tubes 1½" O.D. are ordinarily used, high steam velocity being the basis of design.

Multiple Loop Type

The multiple loop type with external header shown on the opposite page is used where high superheat is required. In this design, the superheater elements are located between the boiler tubes in the first bank. The result is a very desirable superheat temperature characteristic curve with minimum variation of steam temperature over a wide range of boiler rating. The superheater tubes occupy but a very small portion of the area of gas flow so that the draft loss across the superheater is proportionately small.

One end of the element is rolled directly into the dry steam drum, the other being rolled into a seamless header, as shown. With this design a minimum of space is required as the use of cumbersome external piping from the boiler to the superheater is unnecessary. Handhole caps of standard design are provided in the header opposite each tube hole.

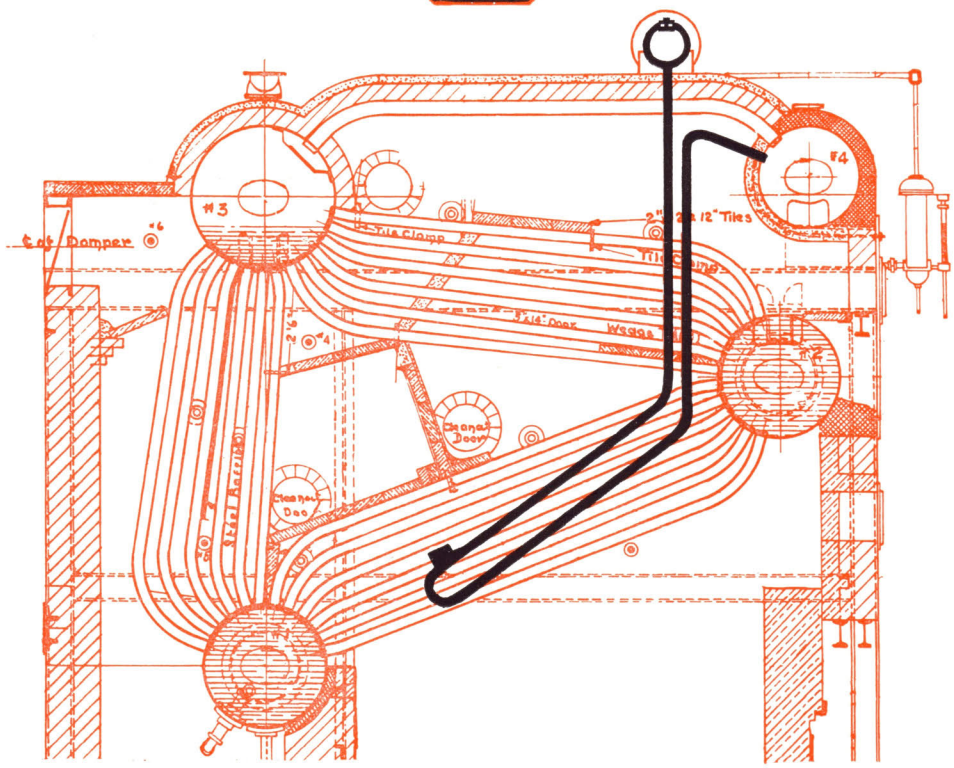
The loops of the superheater are connected by welded tie straps, and each element is supported by special clamps from the top tubes of the lower bank of boiler tubes. As the welded tie straps are cooled by intimate contact with the superheater tube and the supporting clamps are located in sheltered position adjacent to the boiler baffles and in contact with the boiler tubes, they are not subject to deterioration or failure due to overheating.



Cut illustrates the lapped joint prior to forge welding.

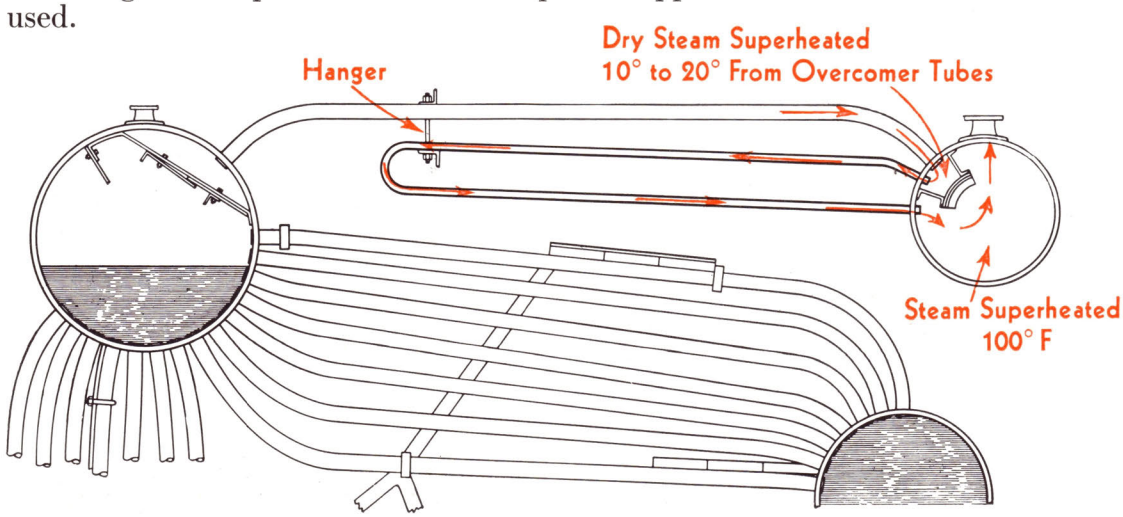
The superheater element is made up of the required number of 30-foot lengths of seamless tubing with lapped and forge welded joints made, as shown, at some point in the straight portion of the tube.

In special cases where space limitations make it desirable, the superheated steam header is placed between the tube banks in the well protected area behind the front baffle.



Single Loop Type

A modification of the multiple loop design, as shown above, is used where a moderate degree of superheat is desired. Special supports of heat resistant material are used.



Single Loop Overhead Type

Where relatively low degree of superheat is required the single loop type is used and the superheater is located at the top of the first pass, as shown. The superheater tubes are rolled directly into the shell of the dry steam drum.

Above is illustrated the typical method of taking steam to the superheater tubes from the overcomer tubes of the Riley-Badenhausen Boiler. This is accomplished, without the use of external piping, by the steam-tight dividing box shown. The channels which form the dividing box are welded to the drum shell, and a gasket is inserted beneath the removable cover to insure steam tightness.

THE DAVIS PRESS WORCESTER MASS. U.S.A.

RILEY~BADENHAUSEN

WATER-COOLED FURNACES

RILEY STOKER CORPORATION

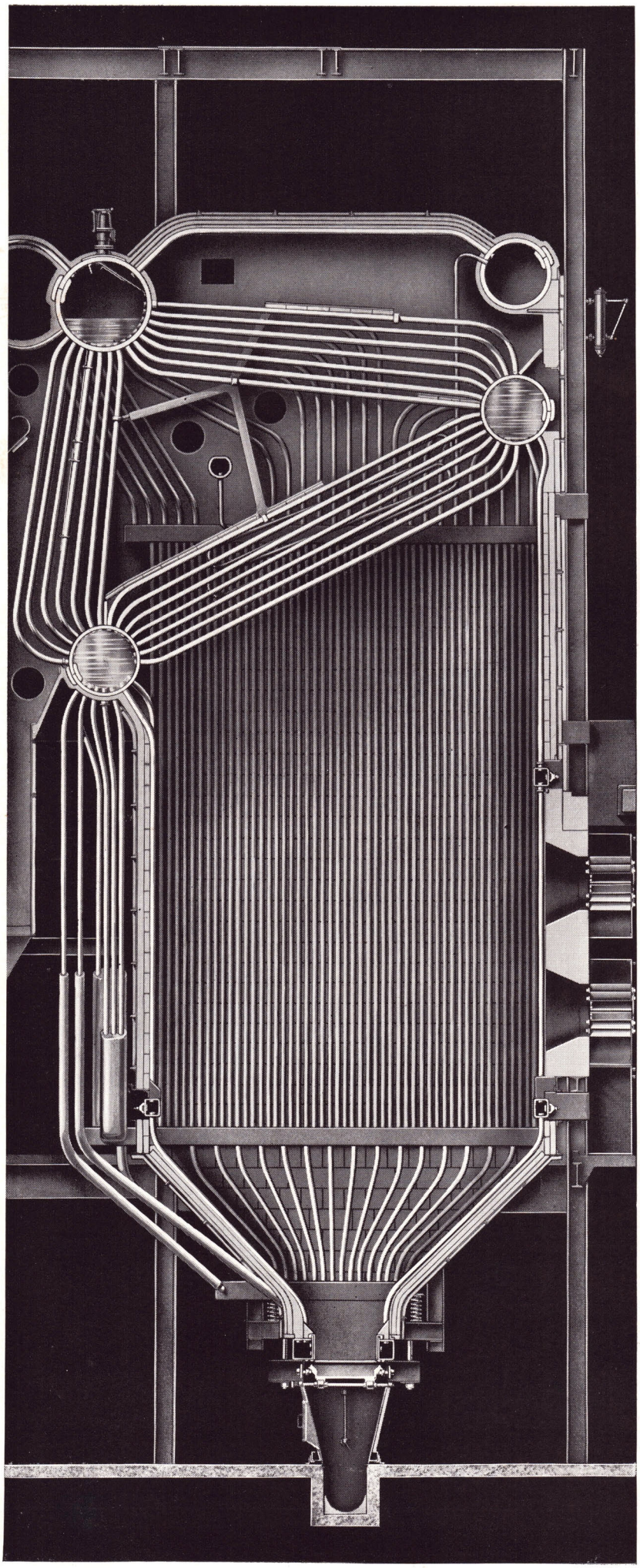
WORCESTER, MASS.

BOSTON NEW YORK PHILADELPHIA PITTSBURGH BUFFALO CLEVELAND DETROIT TACOMA ST LOUIS CINCINNATI HOUSTON
CHICAGO ST PAUL KANSAS CITY LOS ANGELES JACKSON, MISS. DENVER CHARLOTTE EL PASO SALT LAKE CITY NEW ORLEANS

RILEY ENGINEERING AND SUPPLY CO., LTD., TORONTO

Riley Stoker Co., Ltd., London
Fama—France, Italy, Holland, Belgium, Switzerland, Jugo-Slavia
International Machinery Co., (W. R. Grace Co.,) South America
Feuerungsanlagen Aktiengesellschaft, Germany
Andersen-Meyer & Co., China
American Trading Co., Japan

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS
AIR HEATERS • ECONOMIZERS • WATER-COOLED FURNACES



Water Wall Radiant Heat Absorption Makes Possible

↓

Higher Unit Release
Higher Fuel Burning Rates →
Smaller Furnaces

↓

Efficient Operation at High Ratings →

↓

Better Furnace Operation
Higher CO_2 →

↓

Smaller Boilers
Efficient Use of Heat Recovery Equipment →
Low Investment Charges

↓

Reduced Building Costs →

↓

Reduced Furnace Maintenance →

↓

Reduced Boiler Outage →

↓

Lower Radiation Losses →

•

Riley-Badenhausen Water-cooled Furnace with Pulverized Coal Firing

Riley-Badenhausen Water-cooled Furnaces

Water-cooled surfaces absorb large quantities of radiant heat instantaneously and directly from the gases in a furnace, and accordingly their use in boiler furnaces results in the following advantages in overall plant design, boiler and furnace operation and maintenance.

(1) For a given steam output, smaller furnaces can be used, as the permissible B. t. u. heat release per cubic foot of furnace volume for proper operation is very much higher with a water-cooled furnace than with a refractory lined furnace. With stokers, the coal burning rate per square foot of grate surface can also be greatly increased.

(2) In a water-cooled furnace as much as 50% of the total steam may be generated in the water walls by radiant heat absorption. This gives a proportionately lower gas temperature entering the boiler, lower gas volume and, therefore, a material reduction in flue gas temperature leaving the boiler, with lower draft loss, particularly at high ratings.

(3) Water-cooled furnaces permit operation at higher CO_2 and lower excess air for maximum boiler efficiency, without danger of injury to the furnace walls or the creating of undesirable ash slag conditions in the furnace or, with stoker firing, in the fuel bed.

(4) It follows that it is proper to reduce the size of the boiler unit, and to operate it at higher rating. Heat recovery apparatus, either air heater or economizer, or both, can then be used to advantage for increased economy, with low investment charges per unit of steam output.

(5) For a given steam output this makes possible a smaller building with reduction in space occupied and building investment charges.

(6) Water-cooled surfaces reduce furnace maintenance by protection or elimination of refractories.

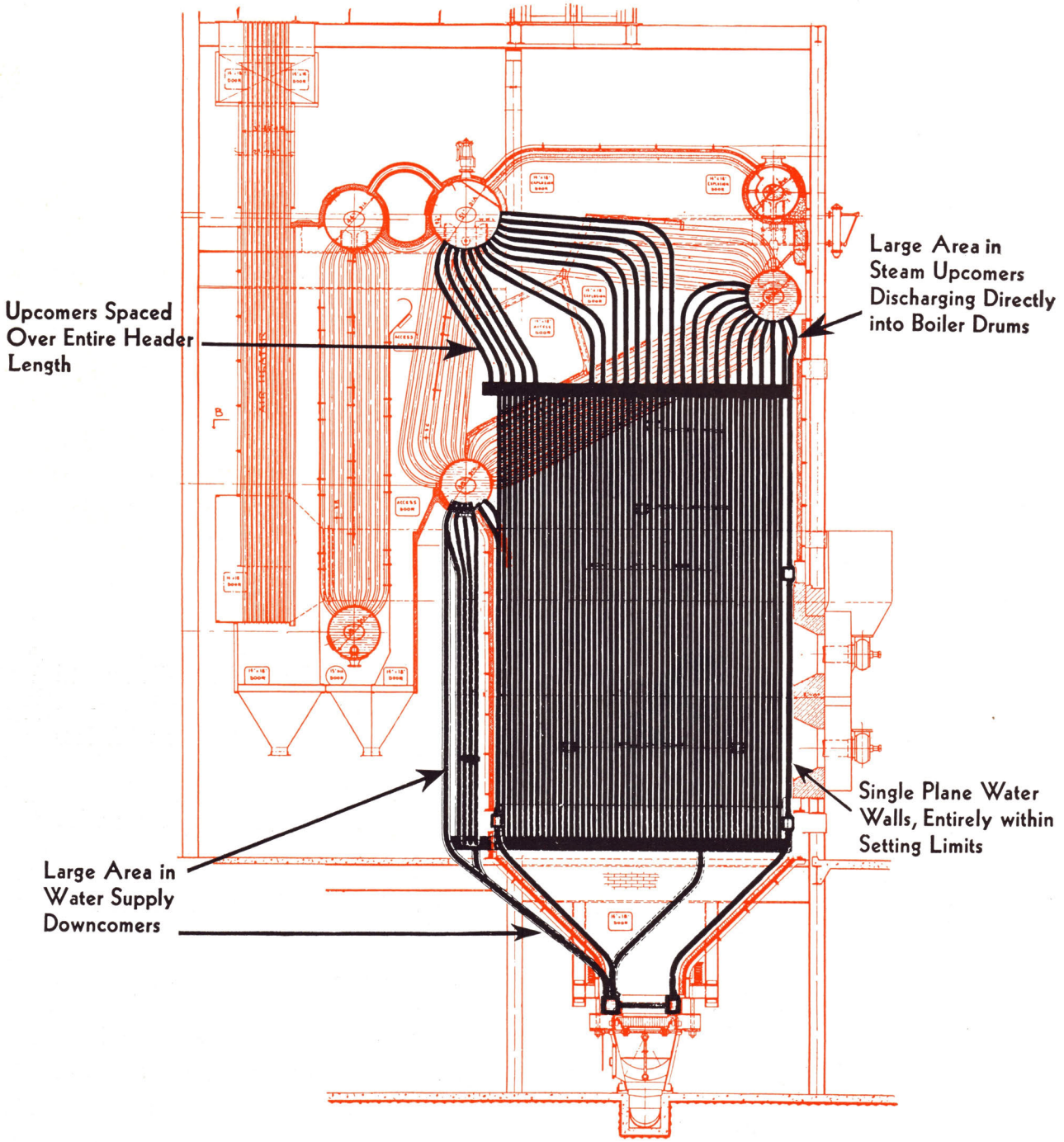
(7) Water-cooled furnaces increase the operating period, avoiding outages which would normally be required for refractory maintenance.

(8) Radiation losses from the setting are materially reduced by the use of water-cooled lining.

Comparison of Costs

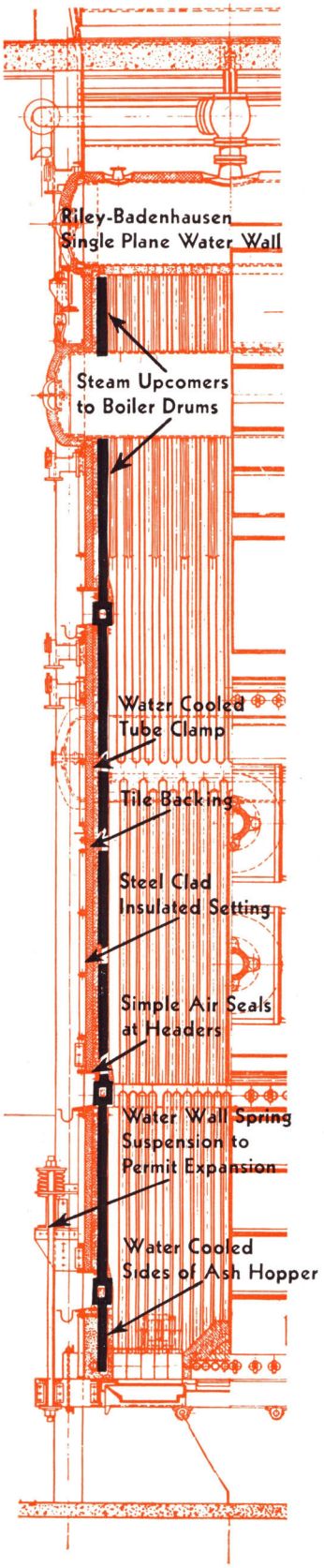
Taking account of the greater steam output possible from a unit designed for high rating with a water-cooled furnace, the initial investment per thousand pounds of steam produced is little if any higher than for a unit with refractory lining, necessarily limited to low rating operation.

Riley-Badenhausen Water-cooled Furnaces


Upcomers Spaced Over Entire Header Length
Large Area in Steam Upcomers Discharging Directly into Boiler Drums
Single Plane Water Walls, Entirely within Setting Limits
Large Area in Water Supply Downcomers

Free and Unrestricted Circulation

Riley-Badenhausen water walls are designed for free and unrestricted circulation, having large area in water supply downcomers and steam upcomers. The result of this design is an adequate supply of water to all parts of the water walls at all times, making the use of recirculators unnecessary.



Riley-Badenhausen Single Plane Water Wall

Entirely within the Setting Limits

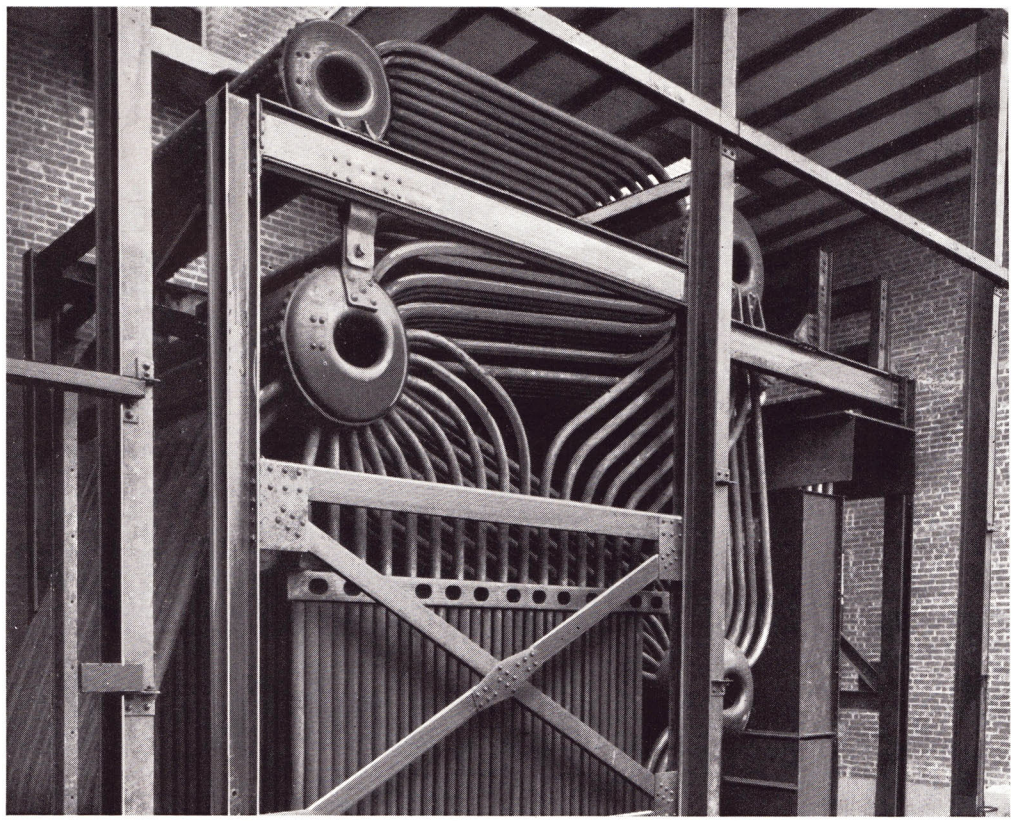
As is clearly illustrated, the Riley-Badenhausen water wall is made up of straight tubes, rolled at each end into rectangular seamless steel headers, connected with the boiler drums by bent tubes entirely within the setting limits.

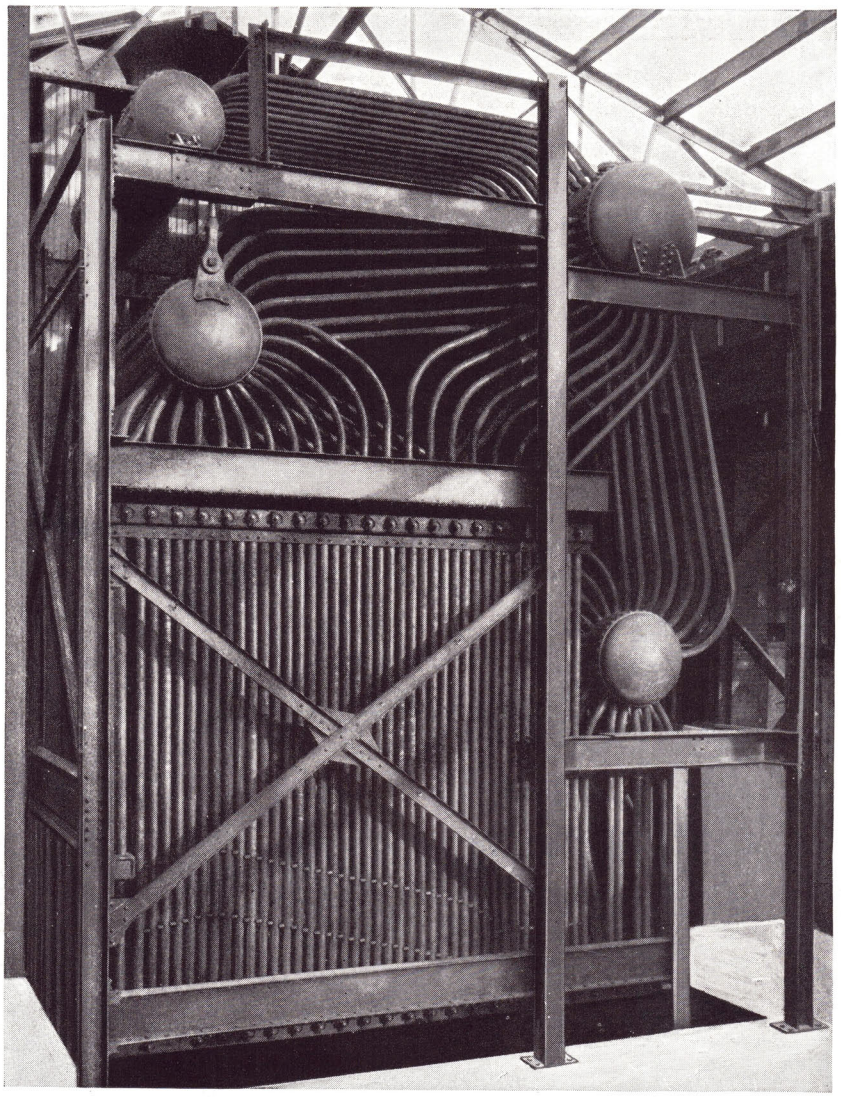
The photograph below plainly illustrates the fact that the Riley-Badenhausen design requires a minimum of setting width. It is to be noted that bulky steam and water circulation pipes outside the setting, with their bulky and expensive covering, are not required.

Tube removal and replacement is greatly simplified in this design where the water wall tubes are entirely inside the setting.

As the water wall tubes do not pass through the boiler casing, the problem of sealing to avoid air leaks at this point is eliminated.

Riley-Badenhausen water walls can be applied to practically all types of water tube boilers.





Construction Riley-Badenhausen Water-cooled Furnaces

Bare tubes 3¼″ O. D. spaced on 4¼″ centers are used in the standard Riley-Badenhausen water wall design. This tube spacing may be varied to suit conditions under which the installation is to operate.

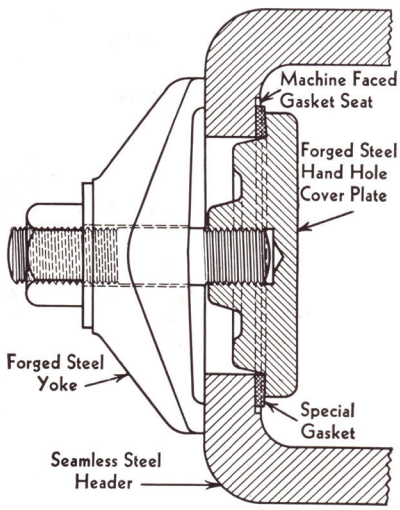
Bare tubes are used because they afford the largest absorption of radiant heat and, therefore, the greatest evaporation and cooling effect. With proper bare tube water wall design, there is virtually no maintenance. Even for very severe service conditions, protection for water wall tubes is not necessary, where water supply is adequate and circulation unrestricted.

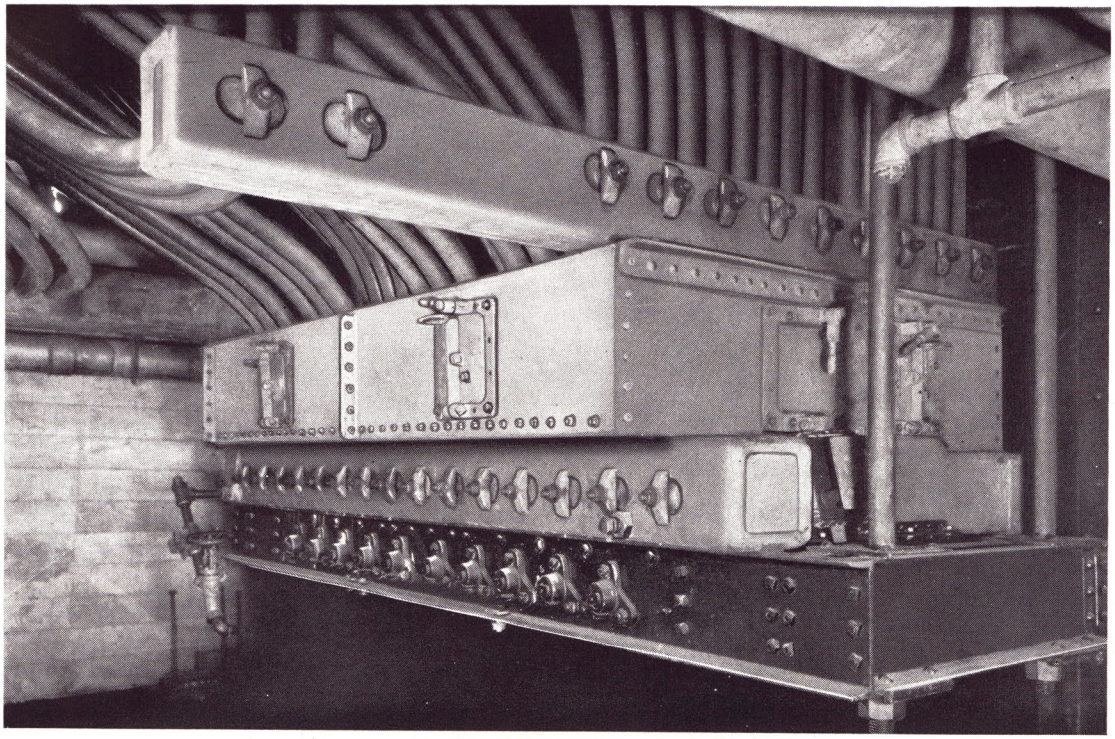
In the steel cased Riley-Badenhausen water-cooled furnace, the tubes are backed up with 12″ x 12″ firebrick tile so that the entire tube is exposed. When conditions make it desirable the refractory is carried to the tube center line. Insulating material is installed behind this tile. Where desirable, standard firebrick walls may be substituted for the tile, insulation and steel casing.

Rectangular seamless steel headers are used. Handholes serve two tubes and are of sufficient size and so arranged as to give ready access to tubes for rolling into the headers and for turbining.

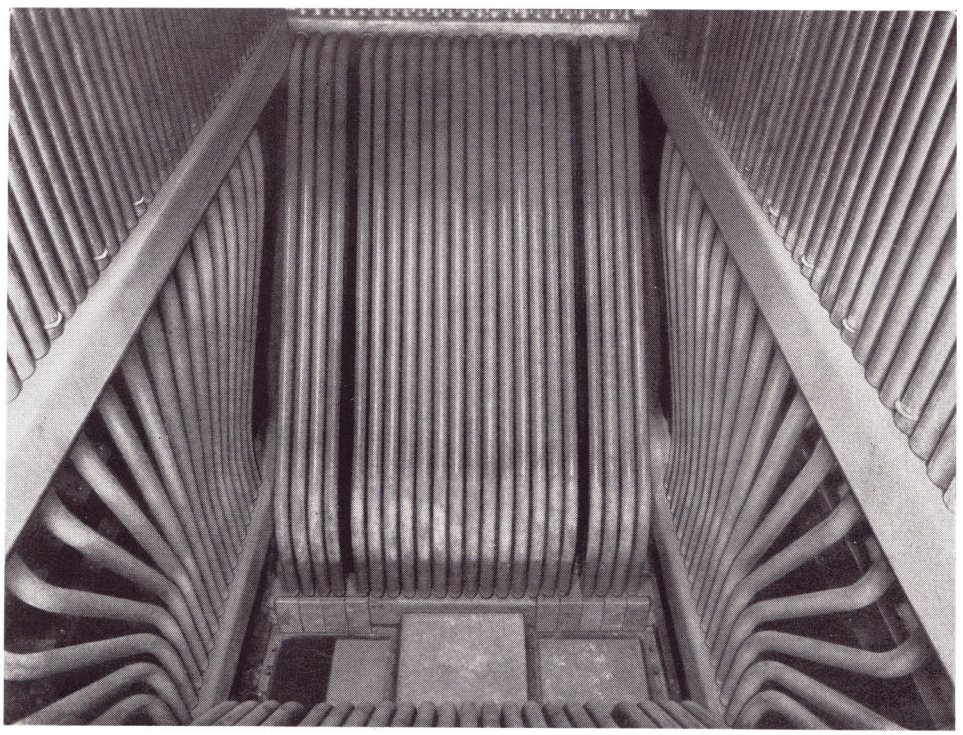
Accompanying illustration shows detail of handhole cover plate, machined inside face of header and special gasket.

Spring suspension of water wall headers is provided to adequately take care of expansion and contraction.

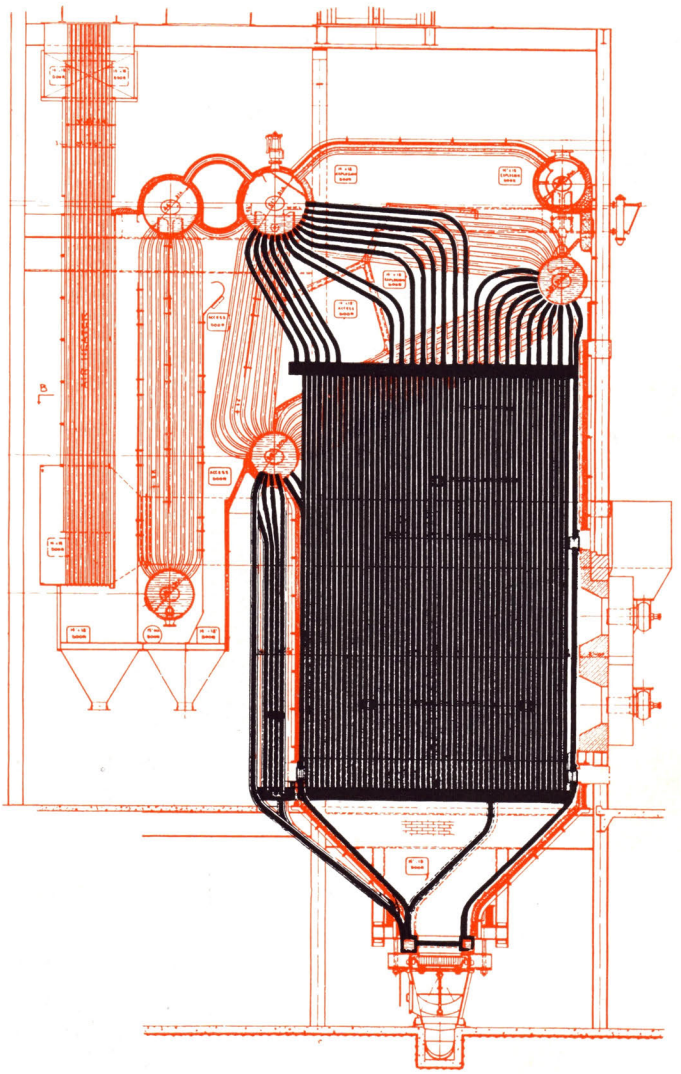




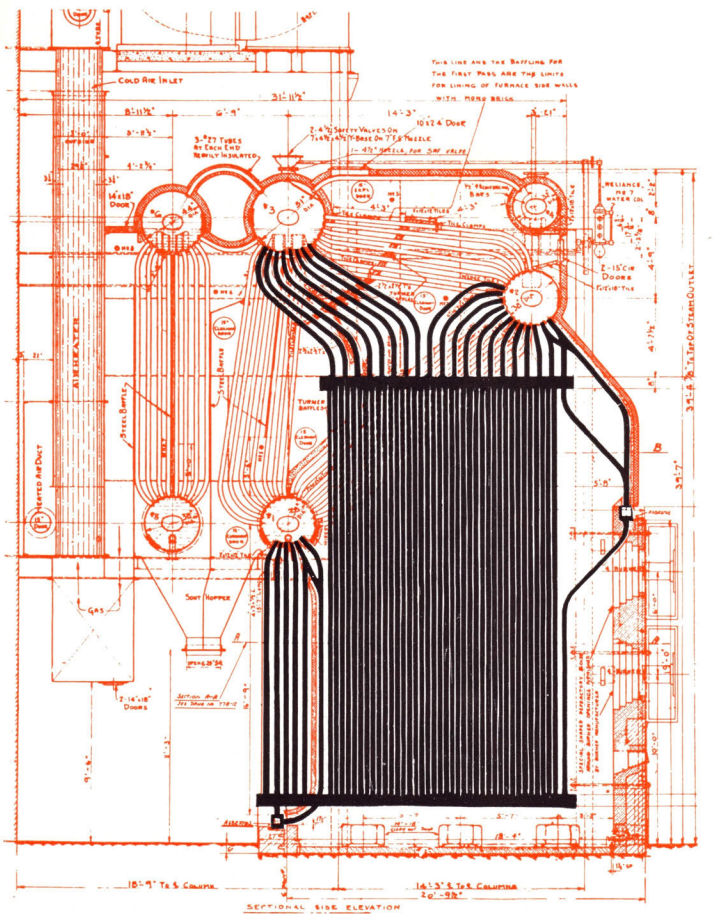
This illustration shows the rectangular seamless steel headers and handhole covers. The large hanger bolts shown at the right of the illustration are spring loaded, as shown on Page 5, to take care of expansion and contraction of the water wall.



A completely water-cooled hopper bottom. The upper photograph is an exterior view of this same installation. The cross sectional drawing of the installation is shown on Page 9.



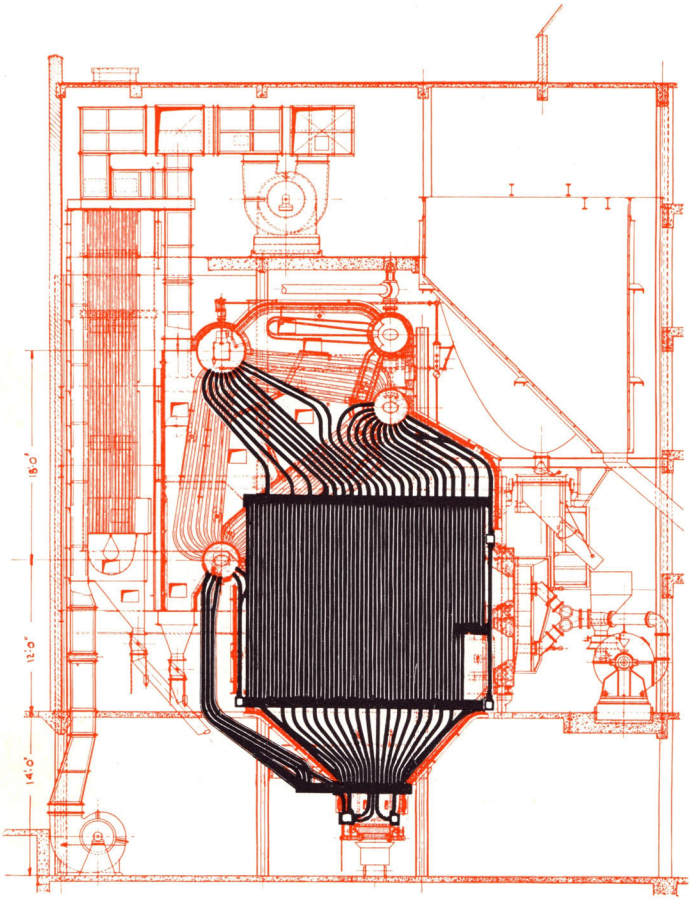
Pulverized coal fired installation with completely water-cooled furnace. Hopper bottom is water cooled at front and rear. All water-wall tubes are within the setting limits, a feature of Riley-Badenhausen water-cooled furnaces. Note the large area of the water supply downcomers and the steam upcomers.

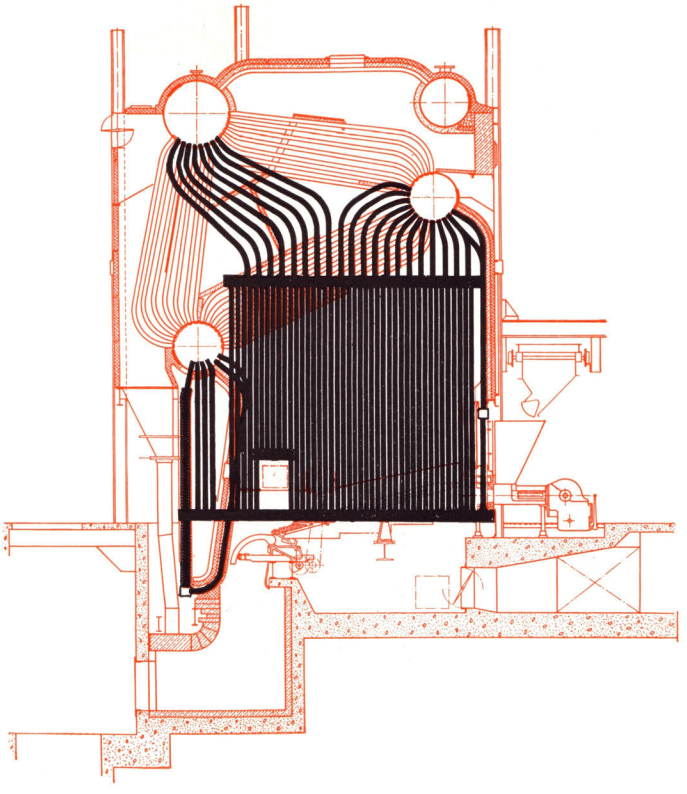


Flat bottom pulverized coal fired furnace with water-cooled side walls, bridgewall and extended front arch. This installation has been in service for four years without the replacement of a single water wall tube. This type of installation is applied with equal satisfaction where gas or oil is burned.

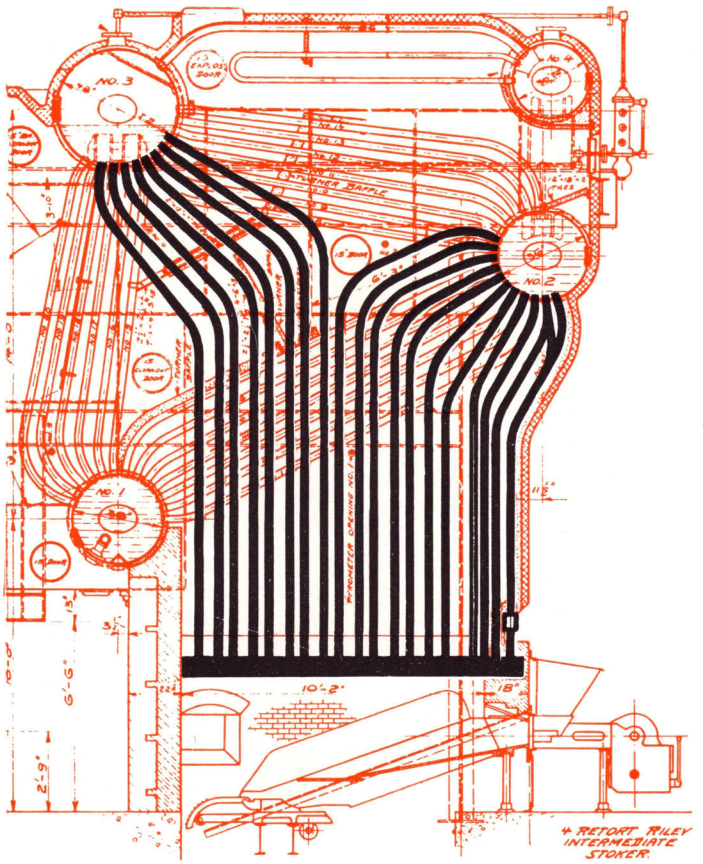
Pulverized coal fired installation with completely water-cooled walls and hopper bottom. At this installation three boilers were originally installed and the foundations erected for the fourth unit. The steam demand increased more rapidly than expected so that it was required to obtain much higher output from the fourth unit than was possible from the three previous units.

The extended front water-cooled arch design made possible increased furnace volume with greater water-cooled wall surface area so that higher steam output was obtained without increasing the boiler size.



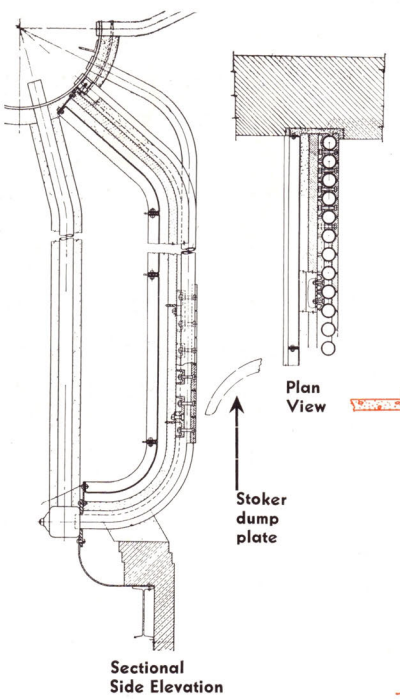


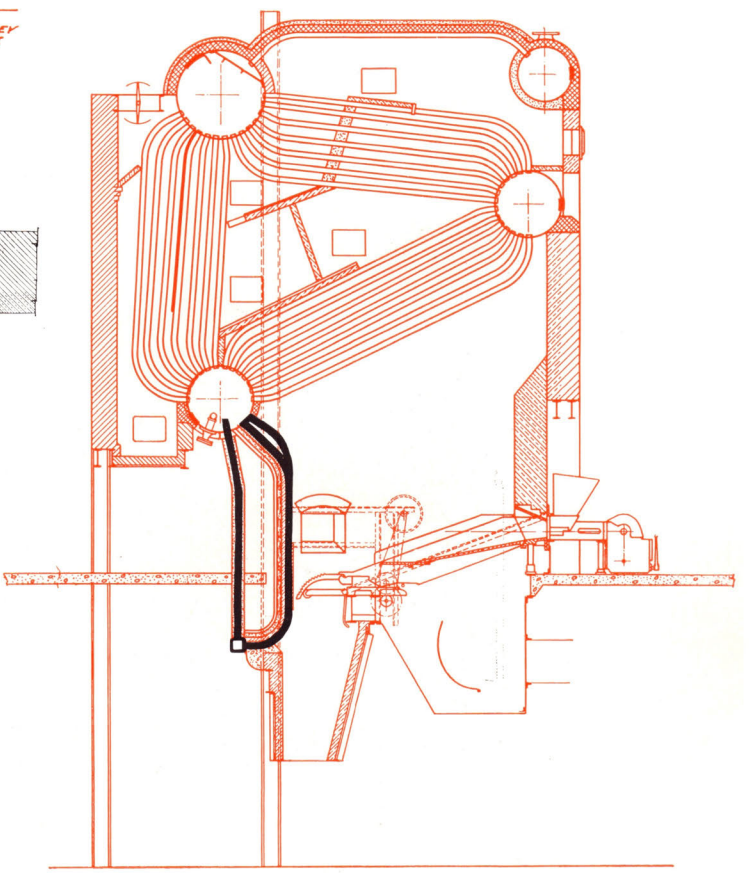
Water cooling is applied to the entire furnace of this multiple retort stoker fired installation. This permits operation of the unit at high rates of output. By water cooling the front wall and extending it slightly, it was possible at this installation to use a stoker of the desired length without increasing the depth of the boiler. Cast iron protecting blocks are bolted to the bridgewall tubes adjacent to the stoker dump plates.



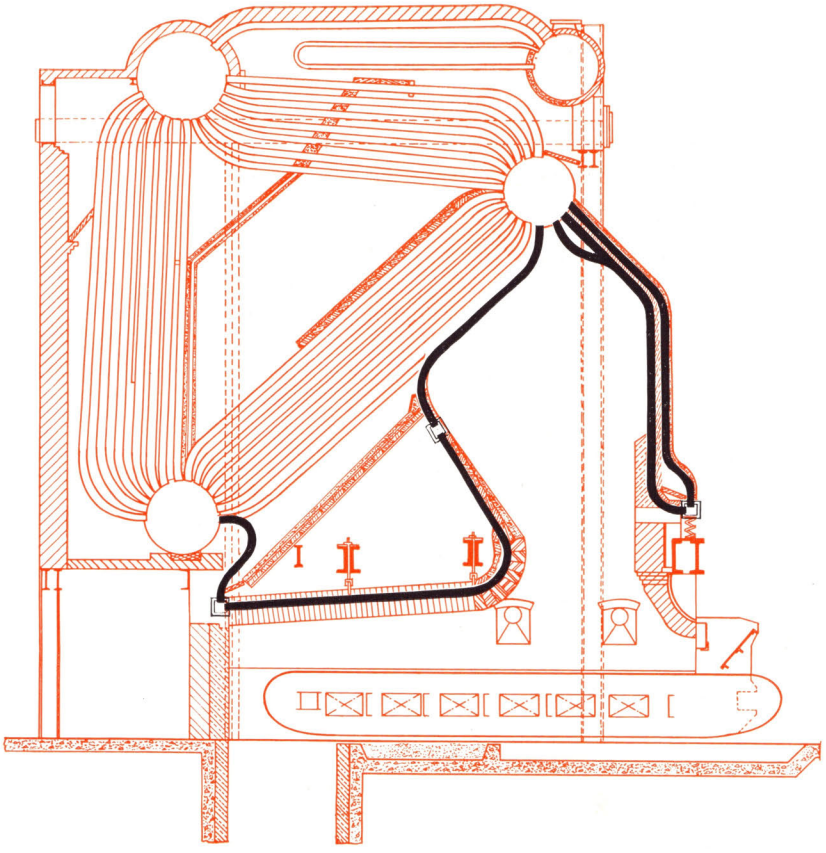
At some installations, rates of operation and load characteristics may be such as not to justify complete water cooling of the furnace. At this installation the desired furnace conditions were obtained by applying water cooling to the side walls. As the amount of water cooling desired did not require the standard spacing of Riley-Badenhausen water-cooled walls, the tubes were spaced on 6½" average centers.

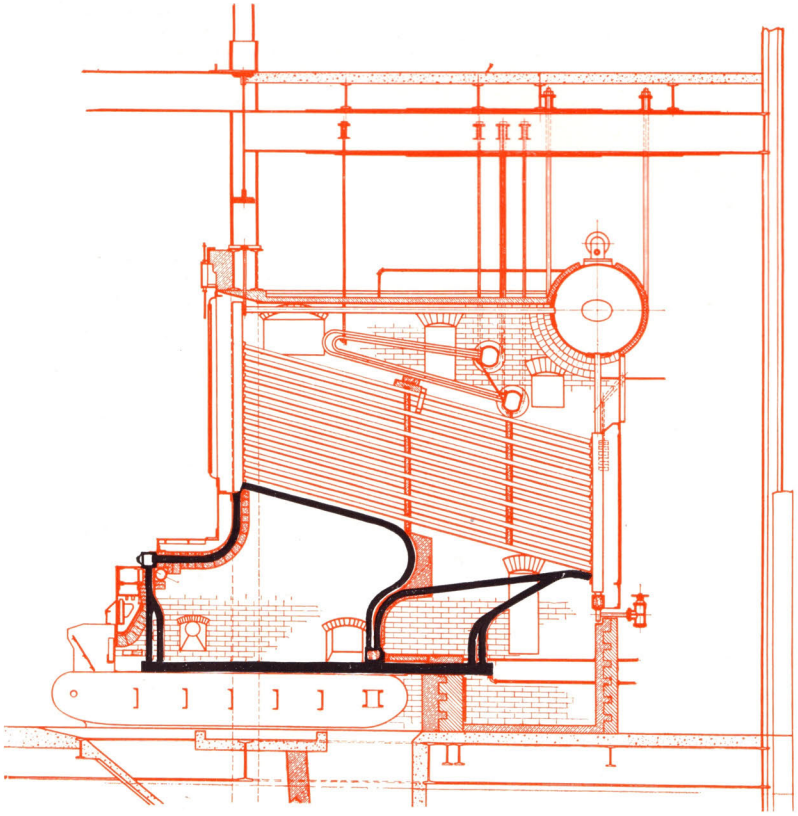
Multiple retort stoker fired installation with water-cooled bridgewall. This simple water wall installation affords complete elimination of bridgewall clinker difficulties and minimizes bridgewall maintenance. This type of installation can be economically applied to existing installations. The accompanying illustration shows details of the protecting blocks and the method used to fasten them to the bridgewall tubes adjacent to the stoker dump plates.





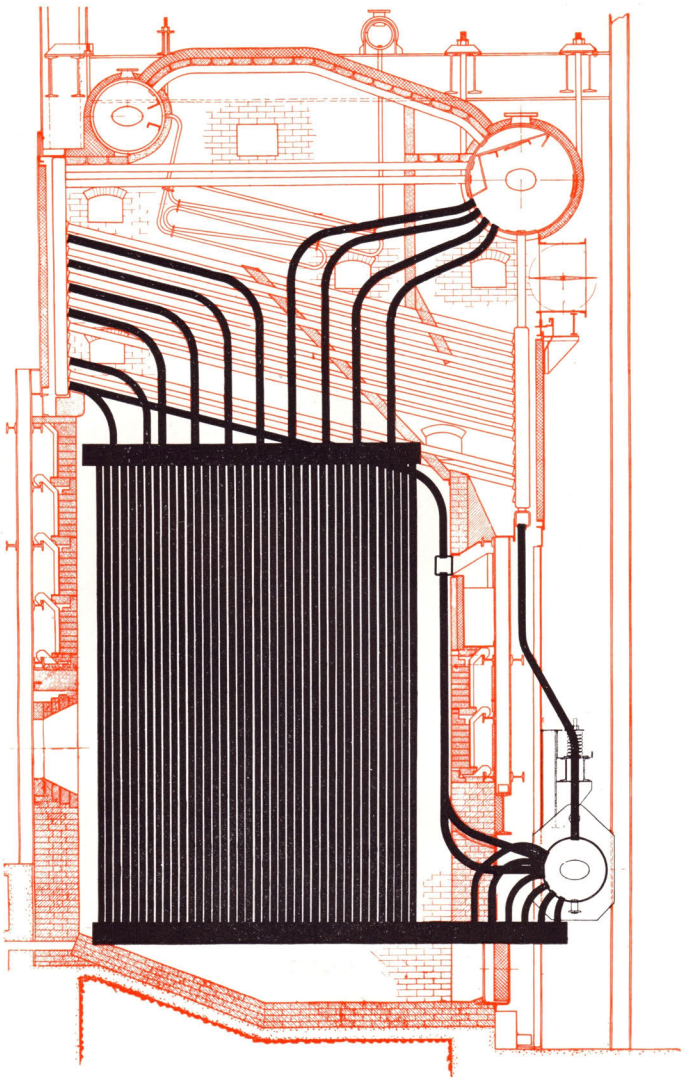
Water cooling as applied to the arches of this traveling grate stoker fired installation has minimized arch maintenance and greatly reduced radiation losses. Note the method used to supply water to the front arch tubes.

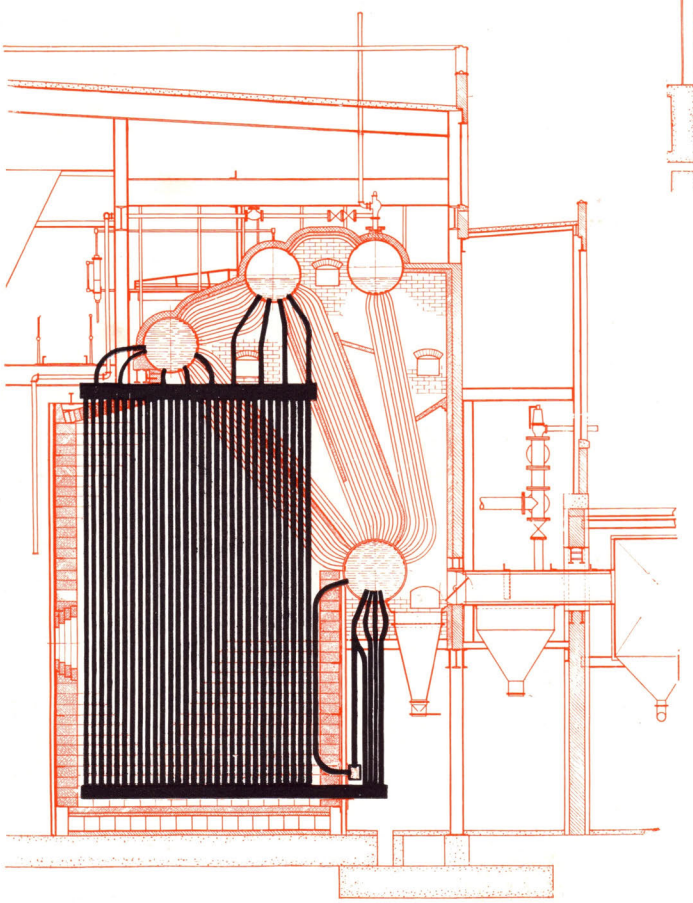




This illustration shows a water-cooled arch applied to a straight tube boiler installation fired by a traveling grate stoker. Badenhausen water-cooled walls and arches can be effectively applied to existing installations of practically all types of water tube boilers.

At this installation it was desired to greatly increase the steam output from the existing boiler unit. High furnace temperatures made this impossible with the existing refractory setting. Water cooling was applied to the side walls and rear wall. By this application of water walls, it is possible to obtain much higher steam output without decreasing the economy of the unit. This is another application of Riley-Badenhausen water walls to a straight tube boiler.





Steam requirements at this installation increased to a point higher than could be obtained economically from the unit with its refractory setting. Water cooling applied to side walls and bridgewall permits operation at the desired high steam output, without sacrificing efficiency of the unit.

THE DAVIS PRESS WORCESTER MASS. U.S.A.

TYPICAL INSTALLATIONS OF RILEY-BADENHAUSEN STEAM GENERATING EQUIPMENT

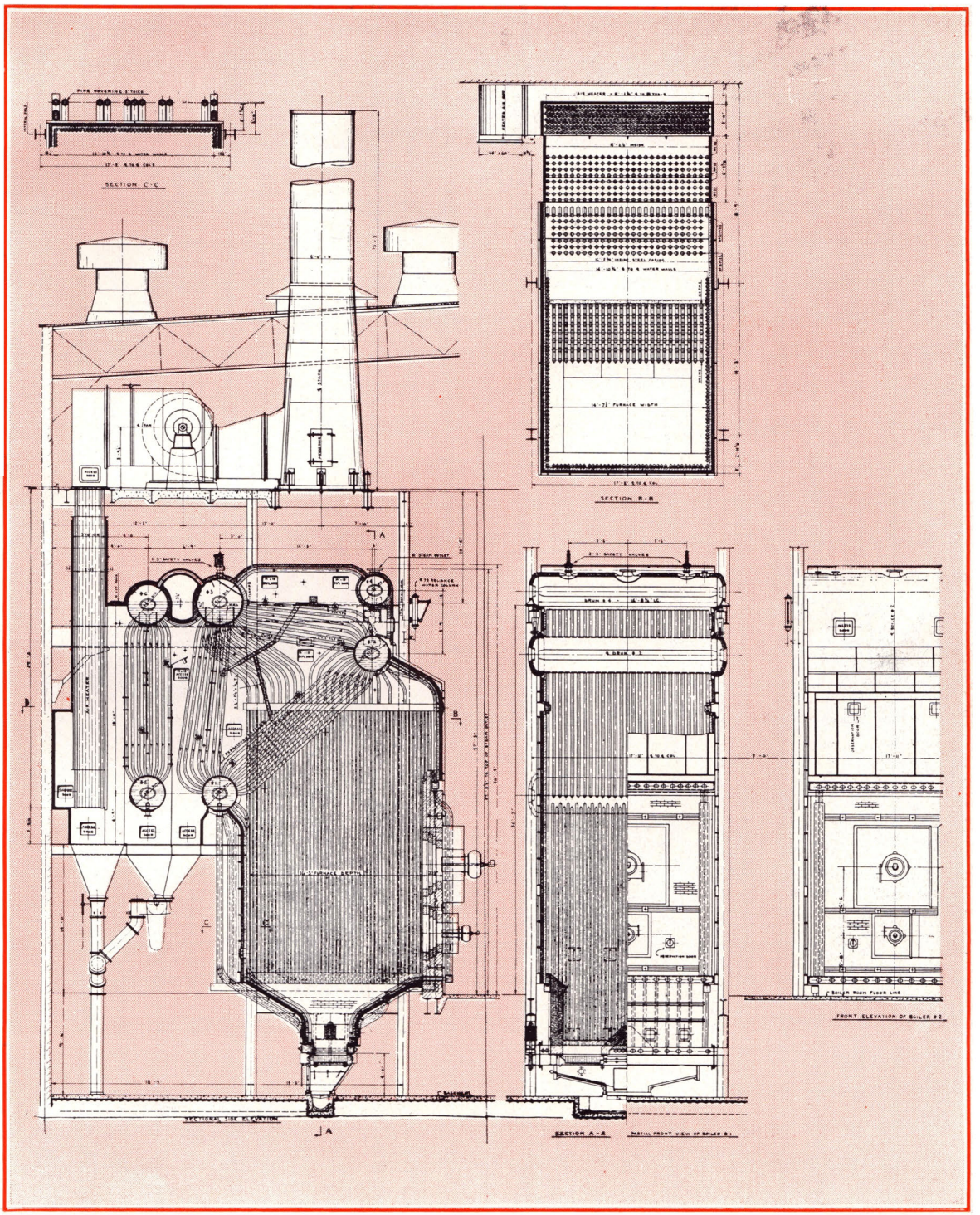
RILEY STOKER CORPORATION
WORCESTER, MASS.

BOSTON NEW YORK PHILADELPHIA PITTSBURGH BUFFALO CLEVELAND DETROIT TACOMA ST LOUIS CINCINNATI HOUSTON
CHICAGO ST PAUL KANSAS CITY LOS ANGELES JACKSON, MISS. DENVER CHARLOTTE EL PASO SALT LAKE CITY NEW ORLEANS

RILEY ENGINEERING AND SUPPLY CO., LTD., TORONTO
Riley Stoker Co., Ltd., London
Fama—France, Italy, Holland, Belgium, Switzerland, Jugo-Slavia
International Machinery Co., (W. R. Grace Co.,) South America
Feuerungsanlagen Aktiengesellschaft, Germany
Andersen-Meyer & Co., China
American Trading Co., Japan

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS
AIR HEATERS • ECONOMIZERS • WATER-COOLED FURNACES

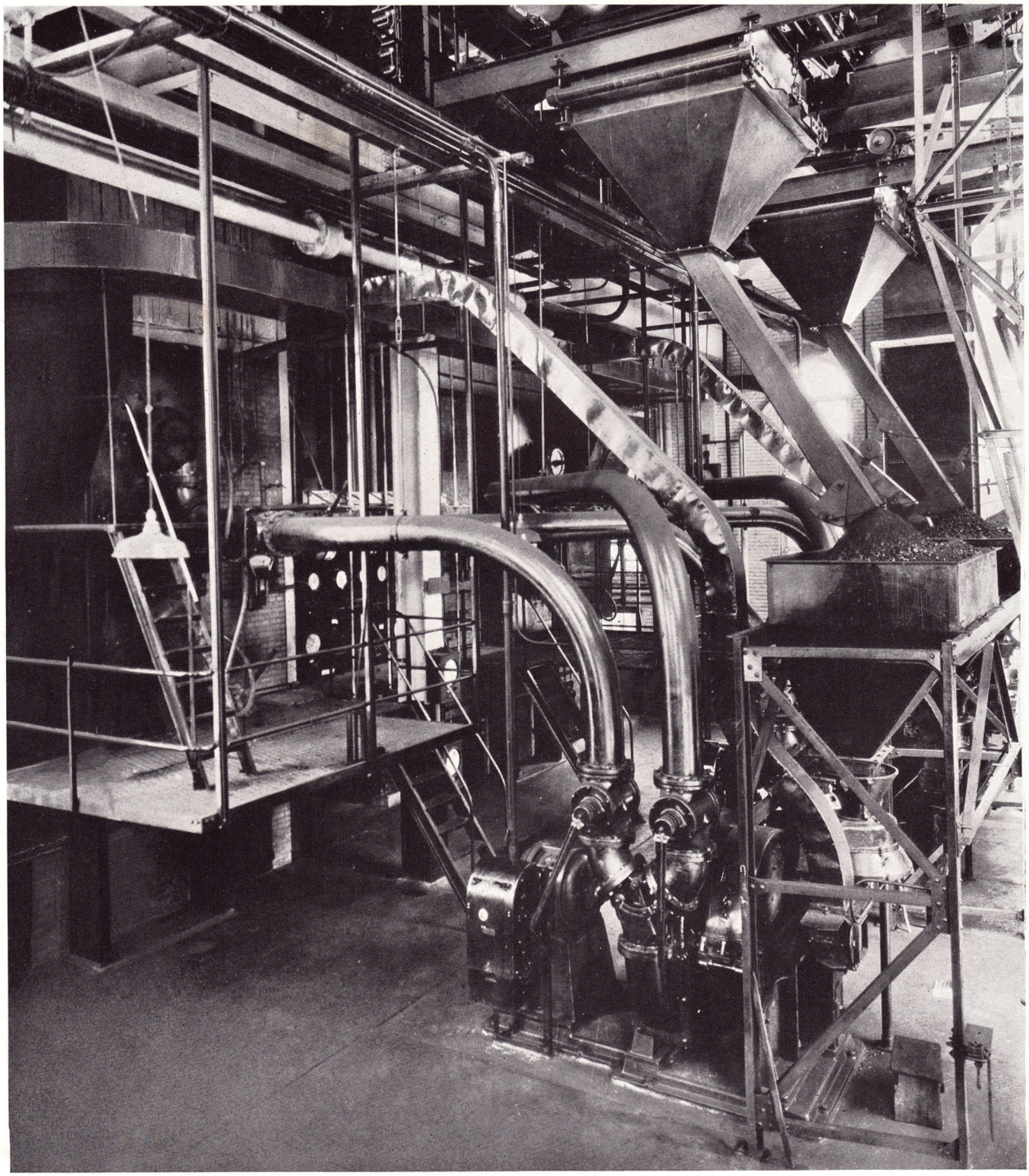
Philip Carey Mfg. Co.
PLYMOUTH MEETING, PA.
W. E. S. DYER, Consulting and Designing Engineer, Land Title Building, Philadelphia, Pa.



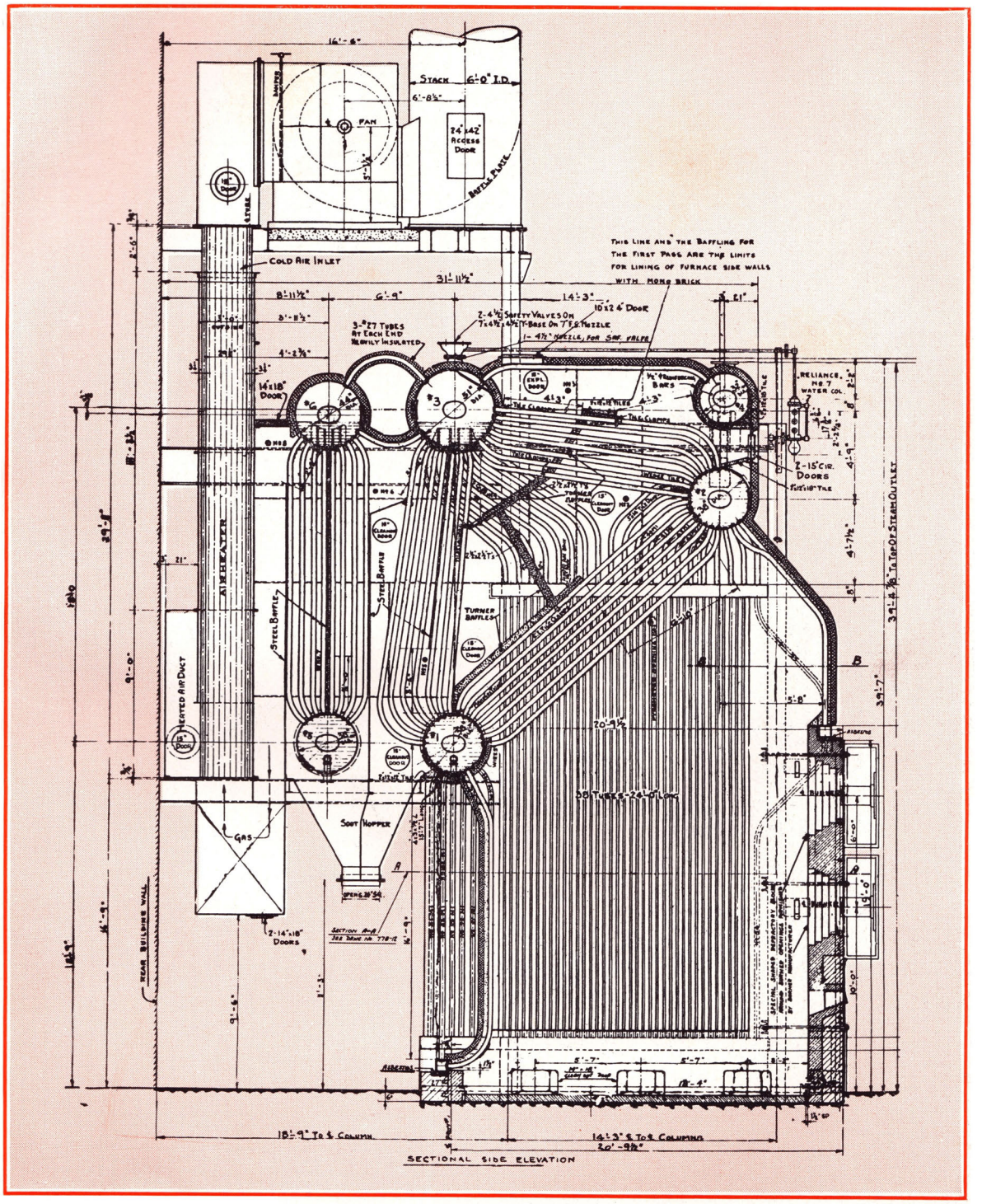
Philip Carey Mfg. Co., Plymouth Meeting, Pa.

Two Riley-Badenhausen Steam Generating Units consisting of Riley-Badenhausen Boilers, Integral Economizers, Air Preheaters, Water-cooled Furnaces, Steel-clad Insulated Settings, Riley Pulverizers and Burners.

PERFORMANCE DATA	Steam Pressure	354 lbs.
	Maximum Steam Output per Unit	130,000 lbs./hr.
	Efficiency—87% at 90,000 lbs. of steam per hour	



Aberfoyle Mfg. Co.
CHESTER, PA.
W. E. S. DYER, Consulting and Designing Engineer, Land Title Building, Philadelphia, Pa.



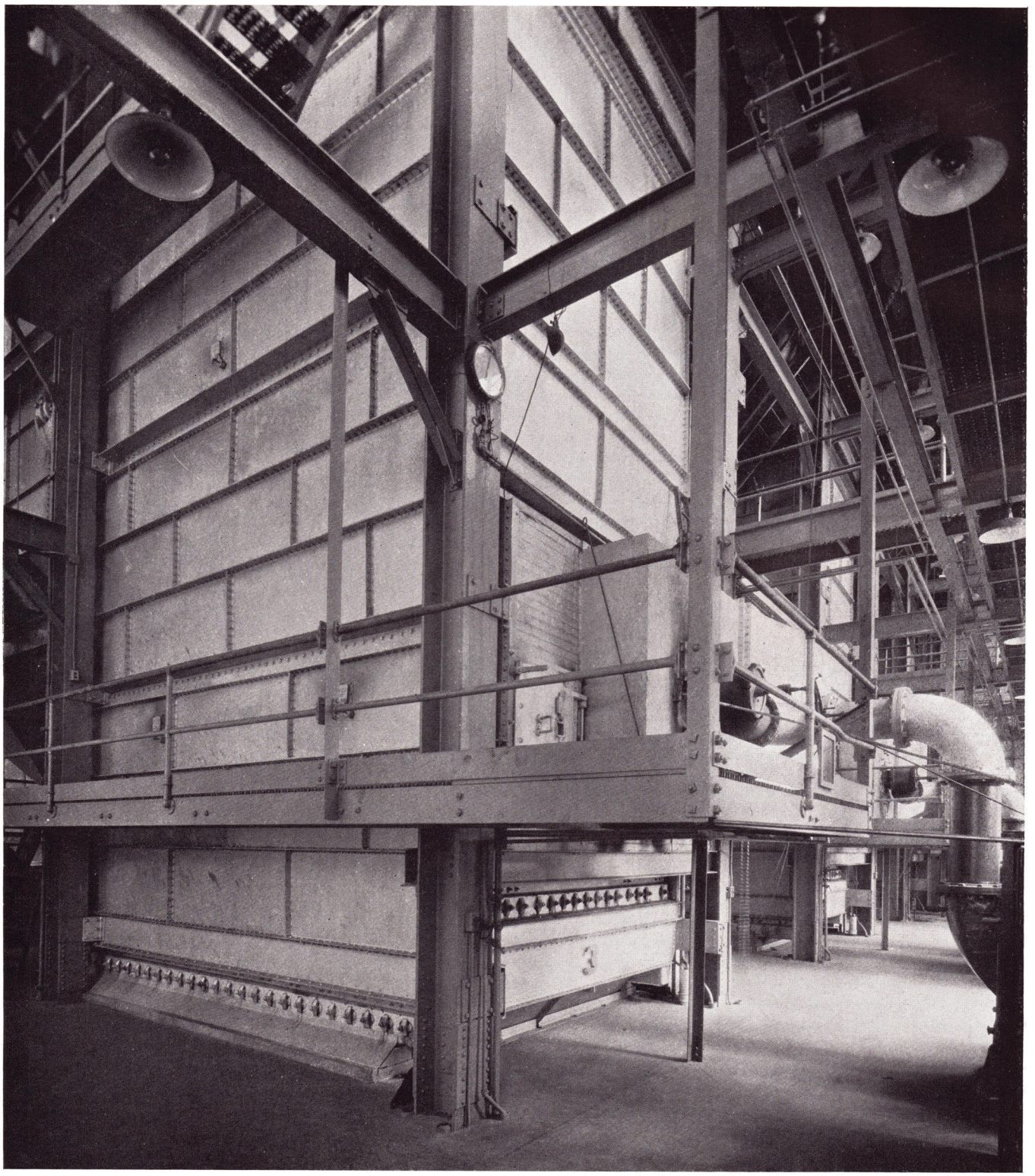
Aberfoyle Mfg. Co., Chester, Pa.

Two Riley-Badenhausen Steam Generating Units consisting of Riley-Badenhausen Boilers, Integral Economizers, Air Preheaters, Water-cooled Furnaces, Riley Pulverizers and Burners.

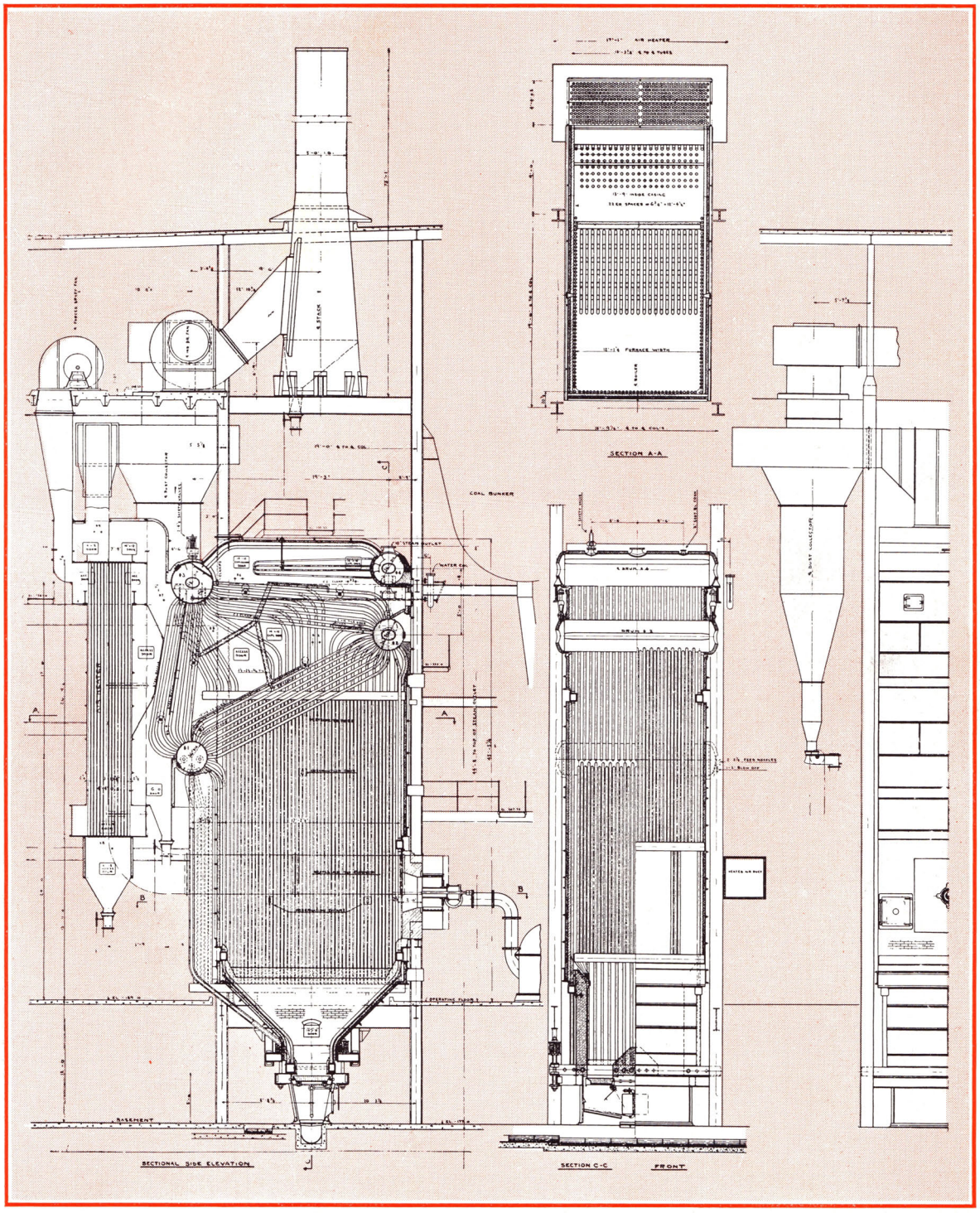
PERFORMANCE DATA

Steam Pressure	300 lbs.
Maximum Steam Output per Unit	135,000 lbs./hr.
Minimum Steam Output per Unit	13,800 lbs./hr.

Test Efficiency—90.3% at 93,000 lbs. of steam per hour
Overall Efficiency over 30-day period—87.0%



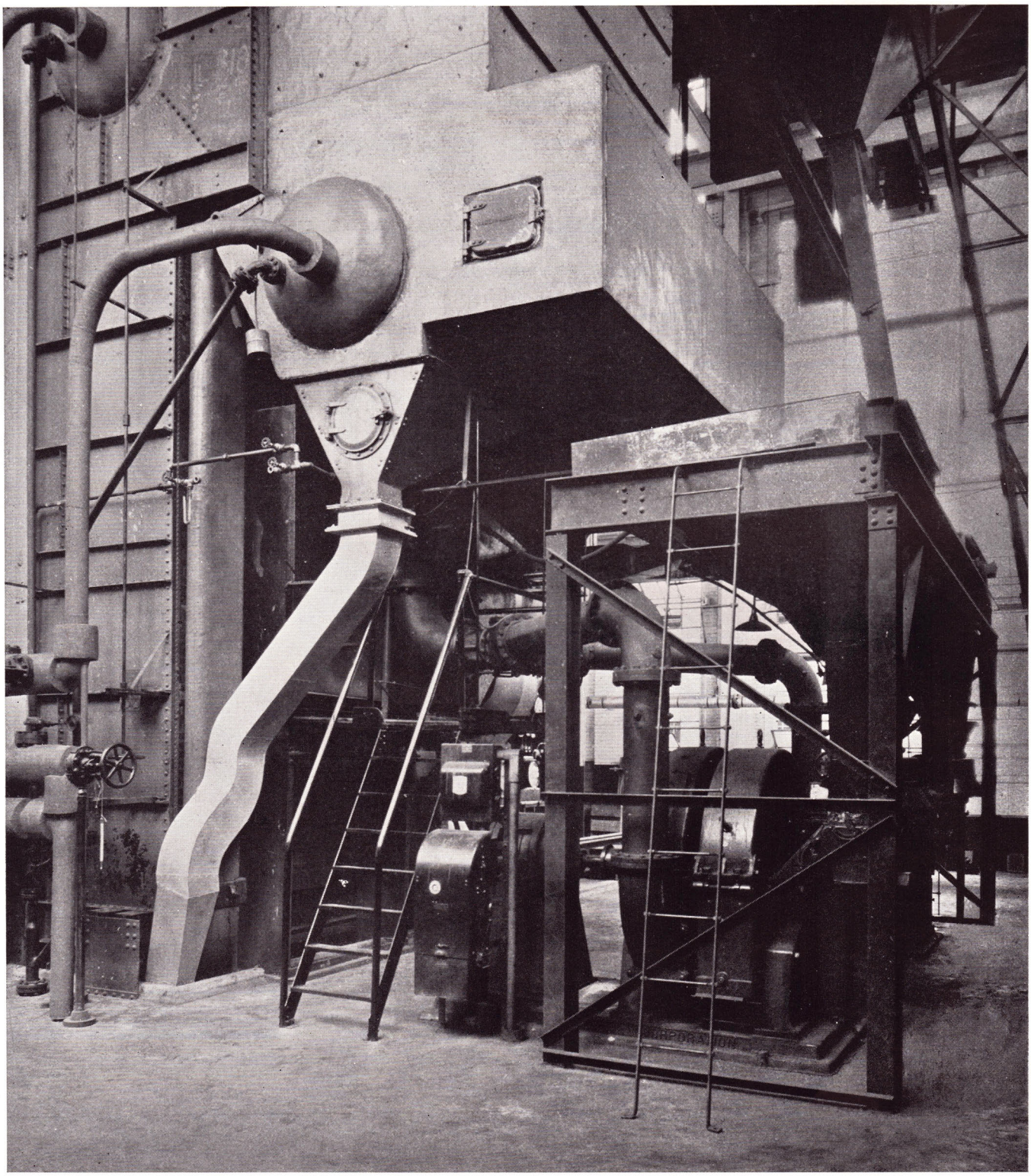
Atwater Kent Mfg. Co.
PHILADELPHIA, PA.
THE BALLINGER CO., Architects and Engineers, Philadelphia, Pa.



Atwater Kent Mfg. Co., Philadelphia, Pa.

Three RILEY-BADENHAUSEN STEAM GENERATING UNITS consisting of Riley-Badenhausen Boilers, Superheaters, Air Preheaters, Water-cooled Furnaces, Steel-clad Insulated Settings, Riley Atrita Unit Pulverizers and Burners.

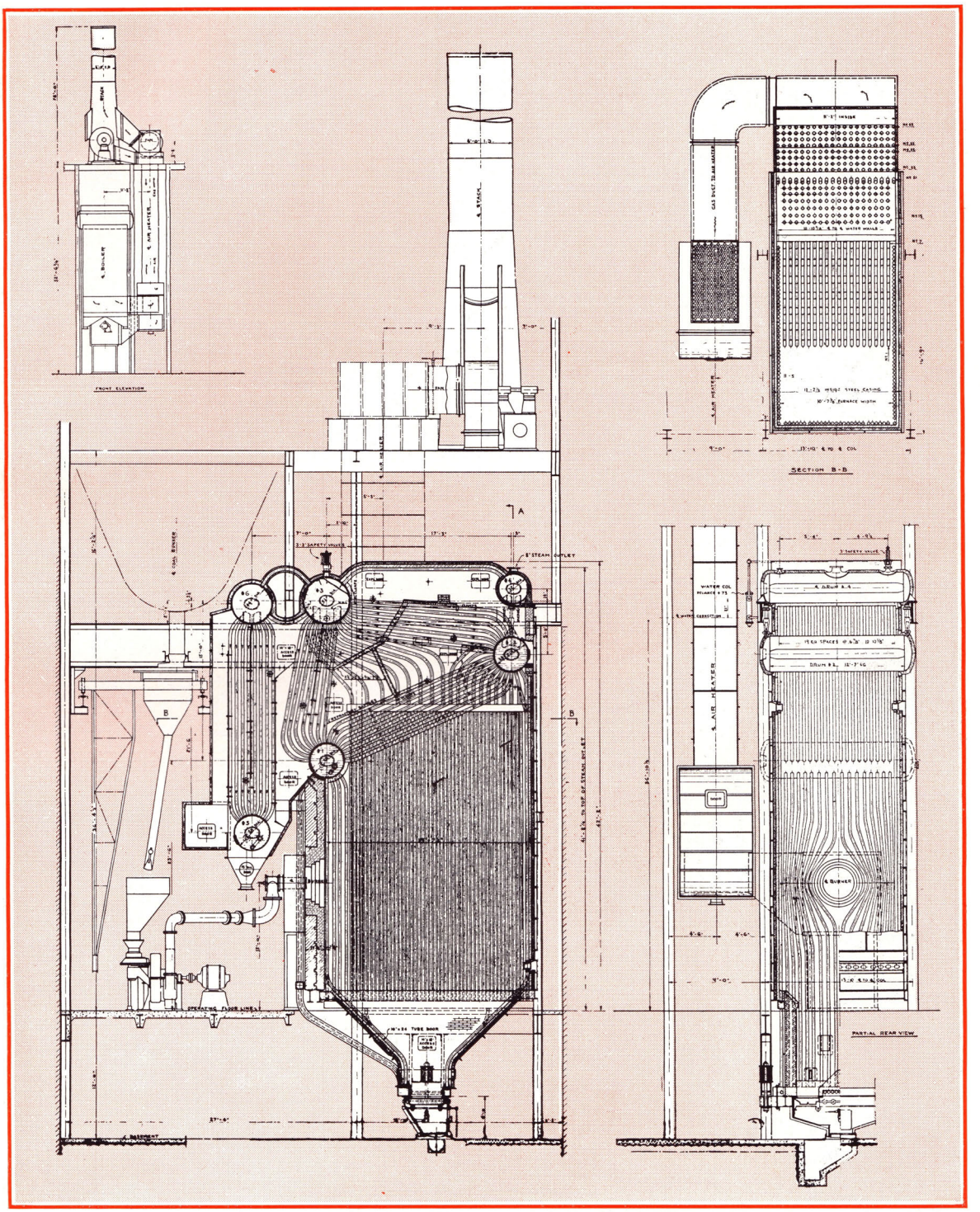
PERFORMANCE DATA	Steam Pressure	200 lbs.
	Maximum Steam Output per Unit	82,000 lbs./hr.
	Normal Steam Output per Unit	45,000 to 62,000 lbs./hr.
	Minimum Steam Output per Unit	26,000 lbs./hr.
	Efficiency—86.64% at 63,610 lbs. of steam per hour	



Sunbury Converting Works

SUNBURY, PA.

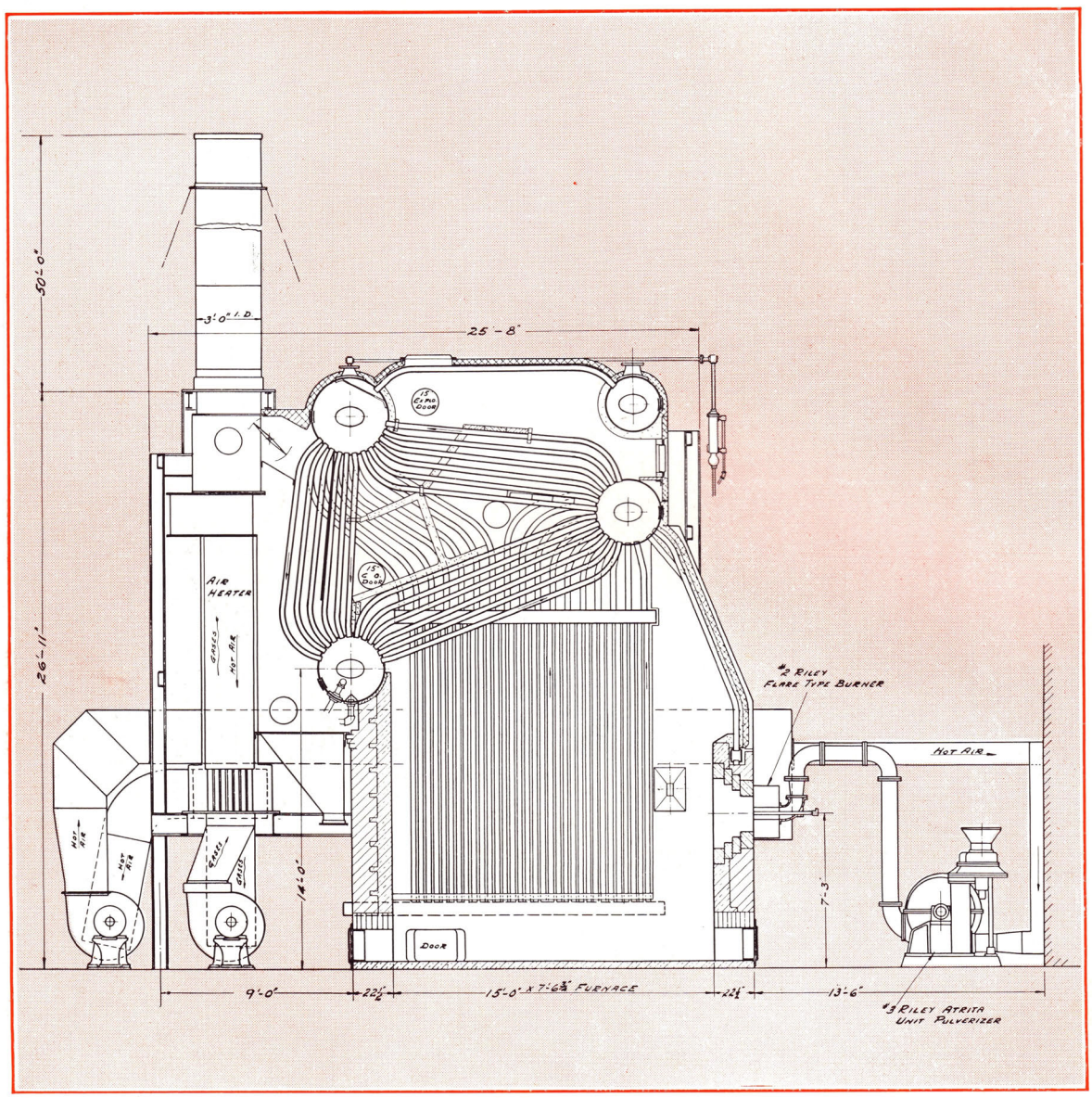
W. E. S. Dyer, Consulting and Designing Engineer, Land Title Building, Philadelphia, Pa.



Sunbury Converting Works, Sunbury, Pa.

One RILEY-BADENHAUSEN STEAM GENERATING UNIT consisting of Riley-Badenhausen Boiler, Economizer, Air Preheater, Water-cooled Furnace, Steel-clad Insulated Setting, Riley Pulverizers and Burner.

PERFORMANCE DATA	Steam Pressure	354 lbs.
	Maximum Steam Output	93,000 lbs./hr.
	Efficiency—88% at 60,000 lbs. of steam per hour	



Imperial Laundry Co., Newark, N. J.

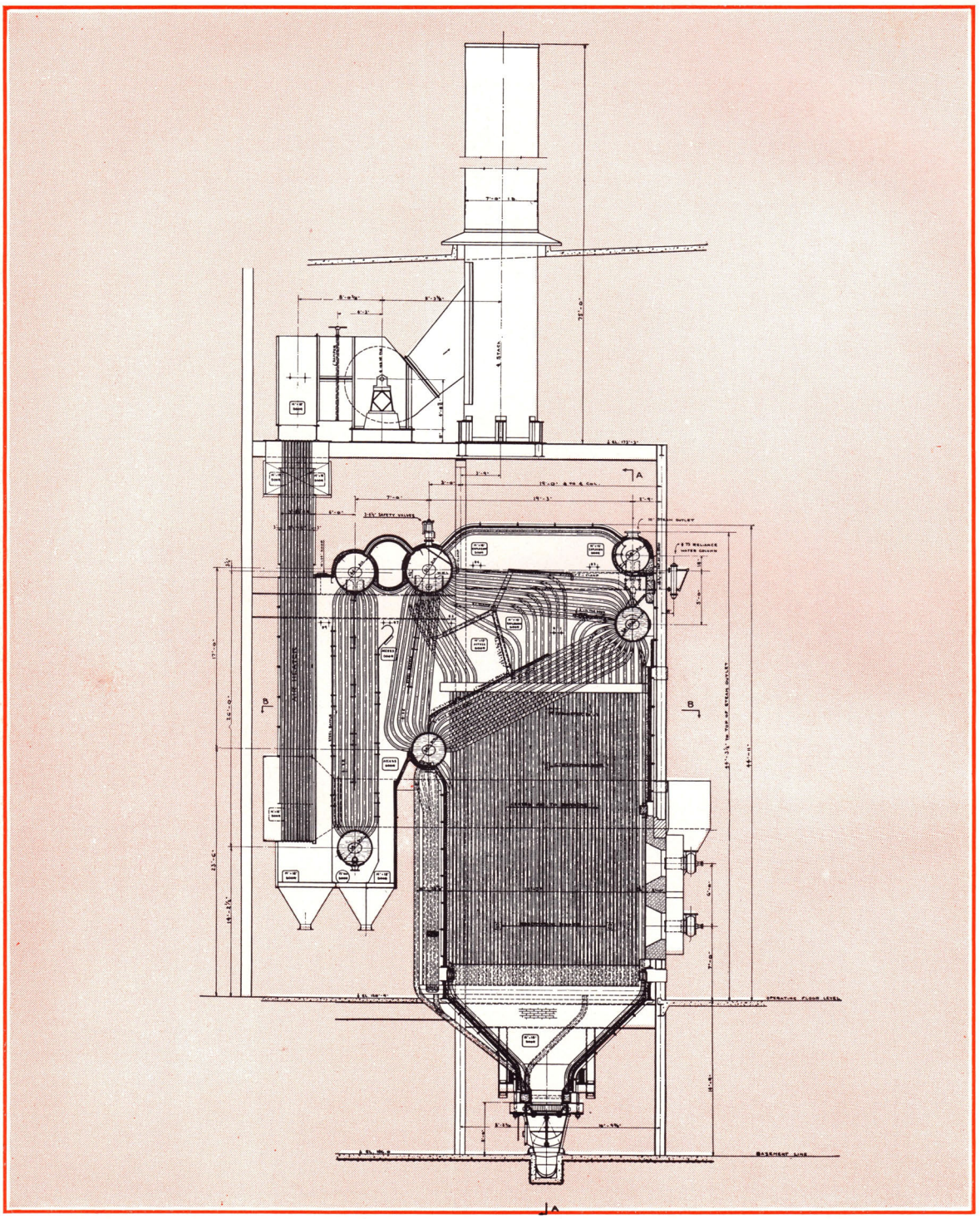
F. A. Phelps, Consulting Engineer, Newark, N. J.

One Riley-Badenhausen Steam Generating Unit consisting of Riley-Badenhausen Boiler, Air Preheater, Water-cooled Furnace, Riley Pulverizer and Burner.

PERFORMANCE DATA

Steam Pressure	160 lbs.
Maximum Steam Output	33,000 lbs./hr.
Normal Steam Output	15,000 lbs./hr.
Minimum Steam Output	6,900 lbs./hr.

Efficiency—82% at 15,000 lbs. of steam per hour

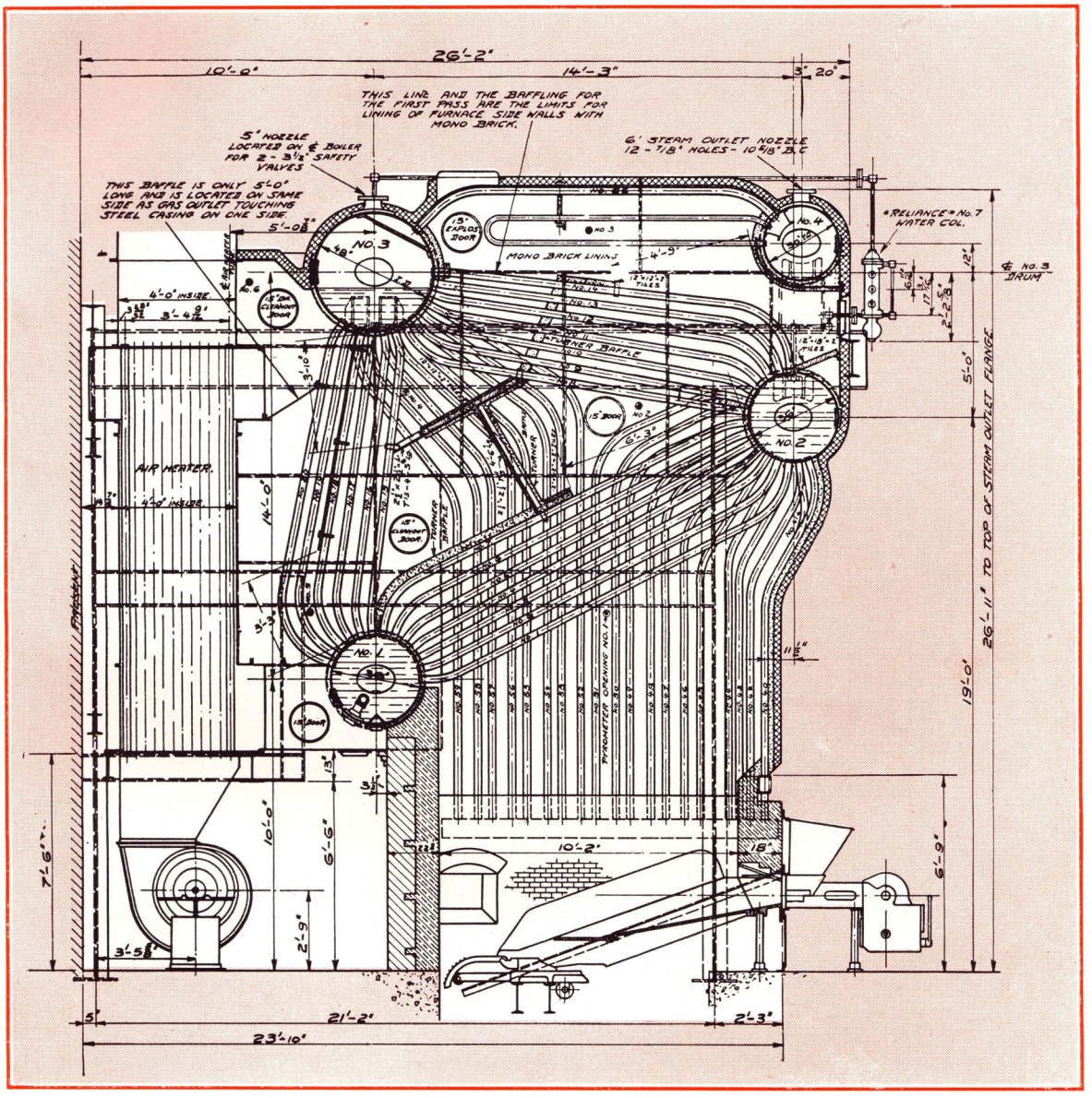


Sunbury Converting Works, Belvidere, N. J.

W. E. S. Dyer, Consulting and Designing Engineer, Land Title Building, Philadelphia, Pa.

Two Riley-Badenhausen Steam Generating Units consisting of Riley-Badenhausen Boilers, Economizers, Air Preheaters, Water-cooled Furnaces, Steel-clad Insulated Settings, Riley Pulverizers and Burners.

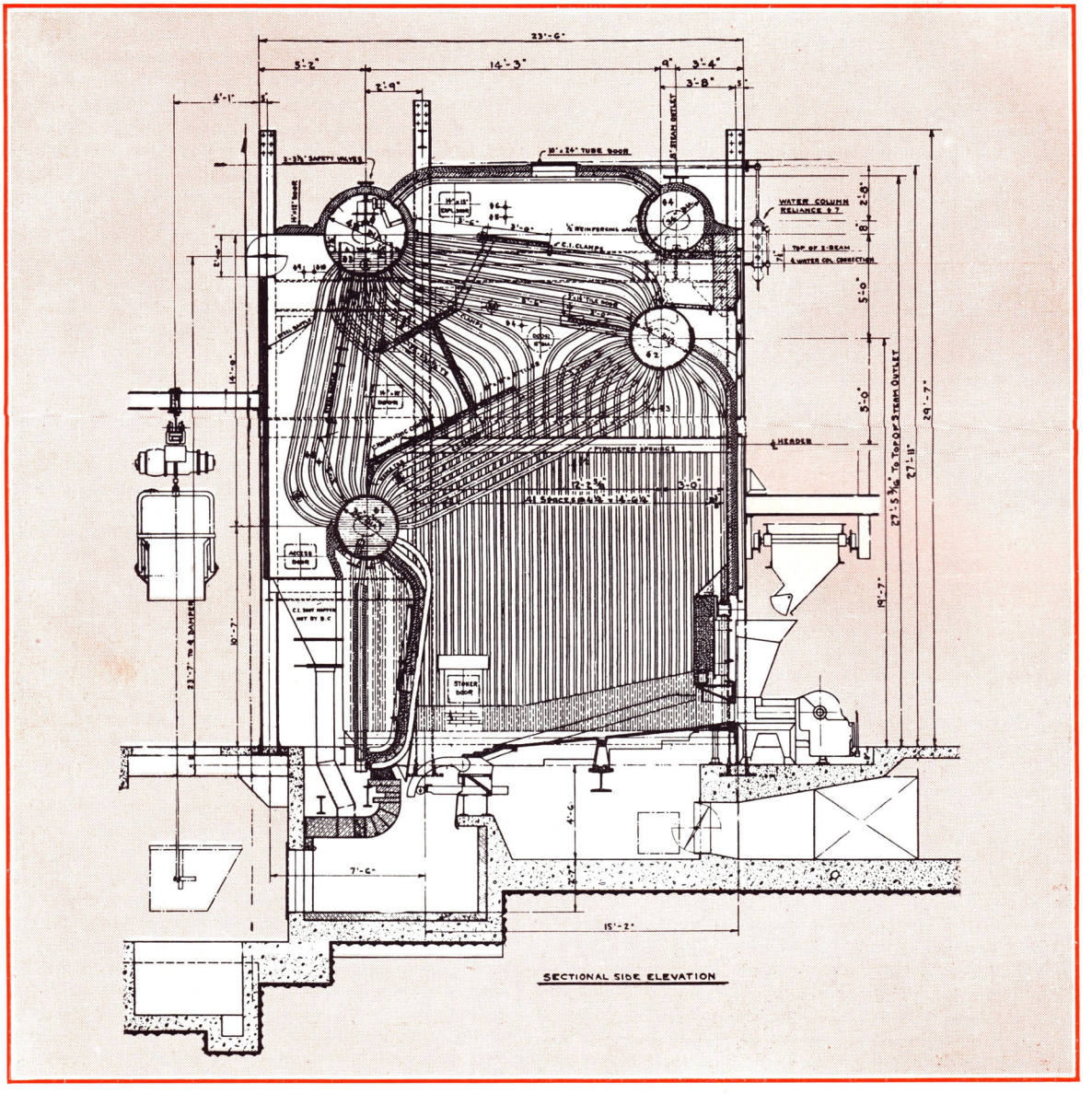
PERFORMANCE DATA		
	Steam Pressure	354 lbs.
	Maximum Steam Output per Unit	172,000 lbs./hr.
	Efficiency—88.24% at 135,000 lbs. of steam per hour	


26'-2"
10'-0"
14'-3"
5'-20"
THIS LINE AND THE BAFFLING FOR THE FIRST PASS ARE THE LIMITS FOR LINING OF FURNACE SIDE WALLS WITH MONO BRICK.
5" NOZZLE LOCATED ON ℄ BOILER FOR 2 - 3½" SAFETY VALVES
6" STEAM OUTLET NOZZLE 12 - 7/8" HOLES - 10 5/8" D.C.
THIS BAFFLE IS ONLY 5'-0" LONG AND IS LOCATED ON SAME SIDE AS GAS OUTLET TOUCHING STEEL CASING ON ONE SIDE.
5'-0⅜"
"RELIANCE" No. 7 WATER COL.
MONO BRICK LINING
℄ NO. 3 DRUM
AIR HEATER.
4'-0" INSIDE
26'-11" TO TOP OF STEAM OUTLET FLANGE.
19'-0"
10'-2"
23'-10"
21'-2"
2'-3"
5'

Harnischfeger Corporation, Milwaukee, Wis.

Two Riley-Badenhausen Steam Generating Units consisting of Riley-Badenhausen Boilers, Superheaters, Air Preheaters, Water-cooled Furnaces, Riley Underfeed Stokers.

PERFORMANCE DATA	Steam Pressure	160 lbs.
	Maximum Steam Output per Unit	40,000 lbs./hr.
	Normal Steam Output per Unit	27,500 lbs./hr.
	Efficiency—84.29% at 25,252 lbs. of steam per hour.	

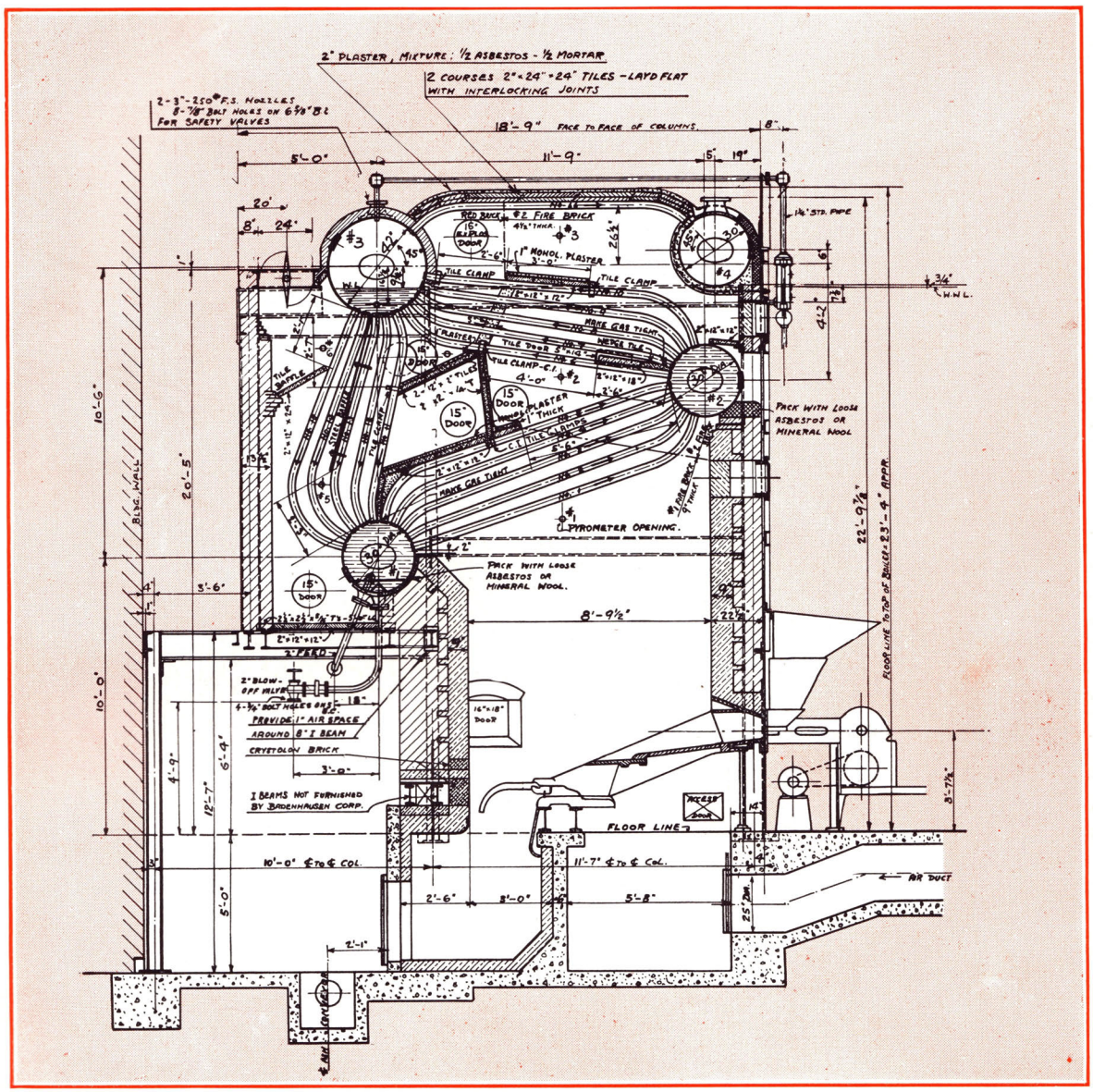


Hoskins-Morainville Paper Co., Menominee, Mich.

L. A. DeGuere, Consulting Engineer, Wisconsin Rapids, Wis.

One Riley-Badenhausen Steam Generating Unit consisting of Riley-Badenhausen Boiler, Water-cooled Furnace, Steel-clad Setting, Riley Super-Stoker.

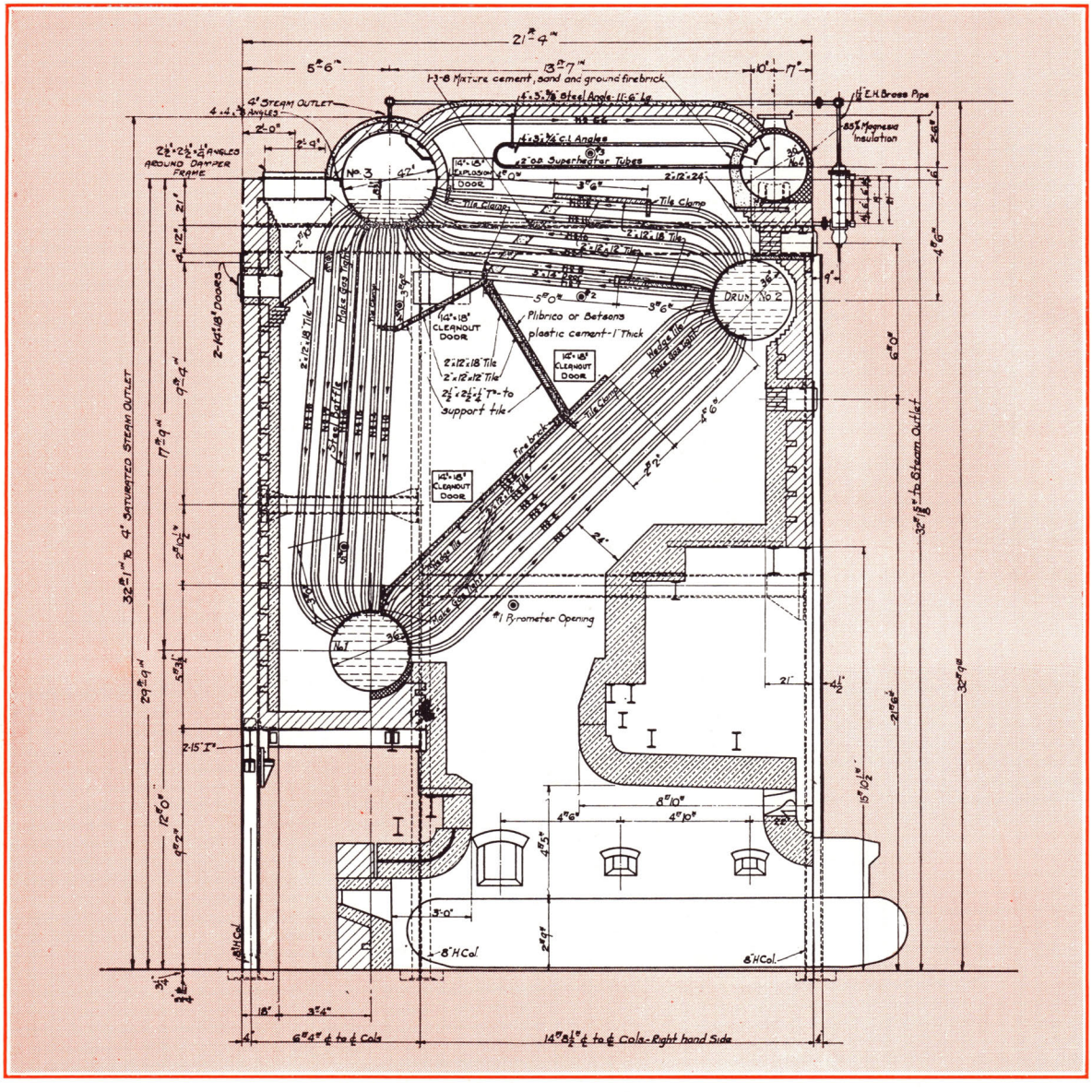
Steam Pressure	165 lbs.
Maximum Steam Output	90,000 lbs./hr.



Cleveland Clinic, Cleveland, Ohio

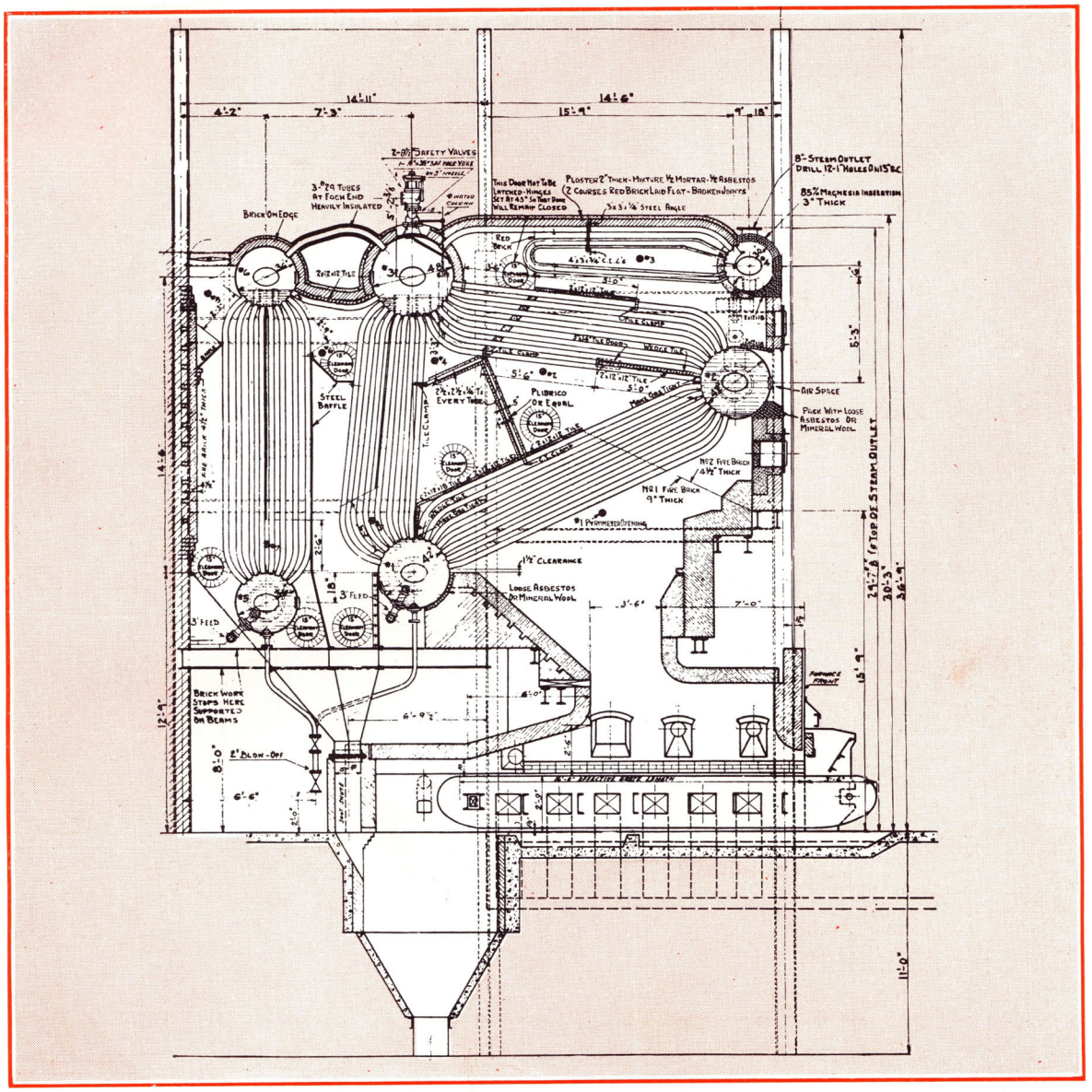
Two—210 H.P. Riley-Badenhausen Boilers
Two—3 Retort Standard Riley Stokers

Boiler Pressure—105 lbs.
81.6% Efficiency at 111.1% of rating



Northern Pacific Railway, Brainard, Minn.

Four—591 H.P. Riley-Badenhausen Boilers
Four—10′ x 14′ Harrington Traveling Grate Stokers

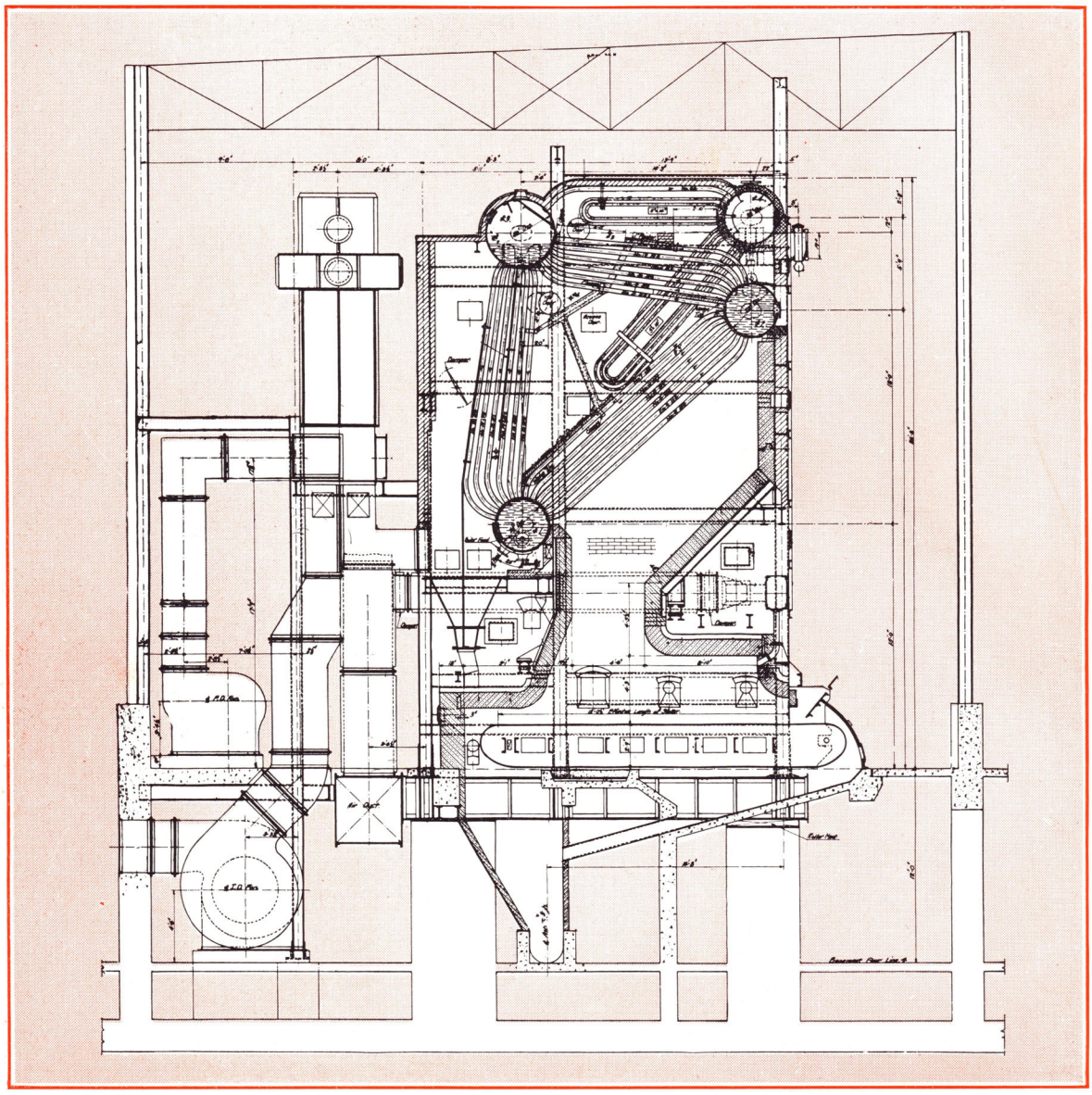


Lehigh Valley Coal Co., Wilkes-Barre, Pa.

Three RILEY-BADENHAUSEN STEAM GENERATING UNITS consisting of Riley-Badenhausen Boilers, Economizers, Harrington Traveling Grate Stokers.

Three—700 H.P. Riley-Badenhausen Boilers
Three—11′ x 16′11″ Harrington Traveling Grate Stokers

300% of rating with No. 3 Buckwheat
No. 4 Buckwheat Anthracite and Silt are also burned at this installation

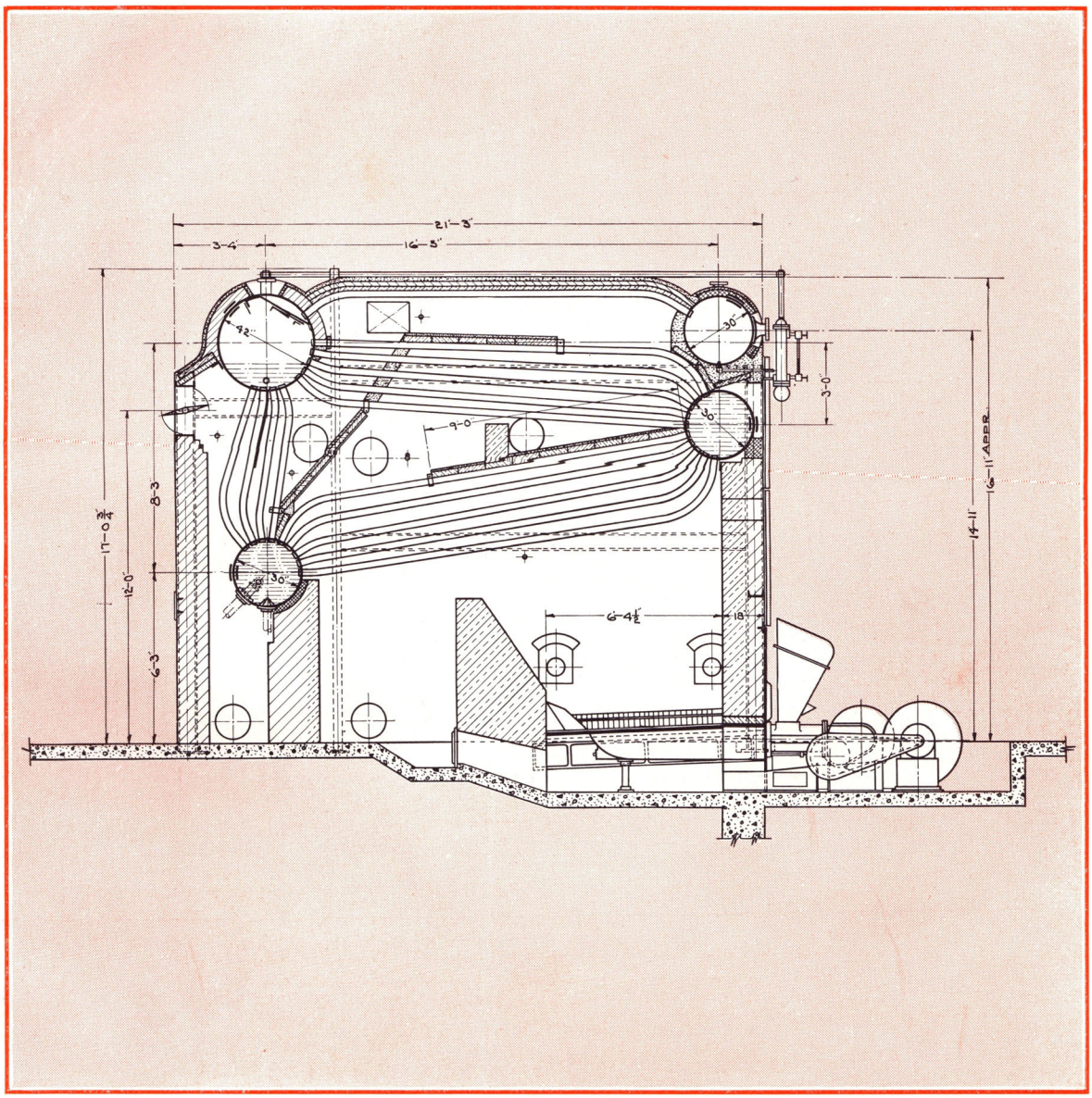


Otter Tail Power Co., Washburn, N. Dakota

Three RILEY-BADENHAUSEN STEAM GENERATING UNITS consisting of Riley-Badenhausen Boilers, Superheaters, Air Preheaters, Harrington Traveling Grate Stokers.

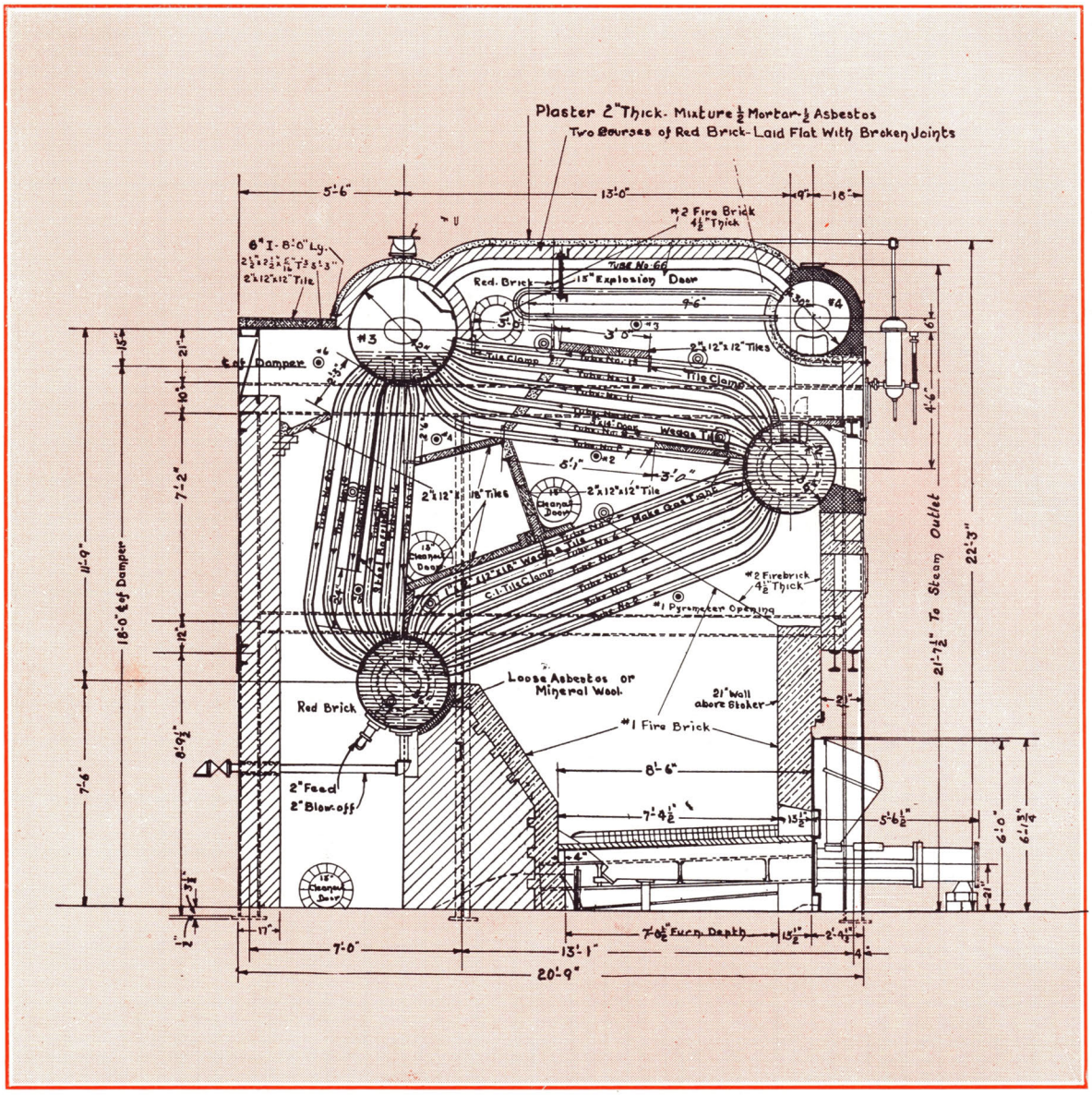
Three—500 H.P. Riley-Badenhausen Boilers
Three—10′ x 15′2½″ Harrington Stokers

Maximum steam output 69,000 lbs./hr. when burning Lignite of 6300 B.T.U. with 37% moisture.



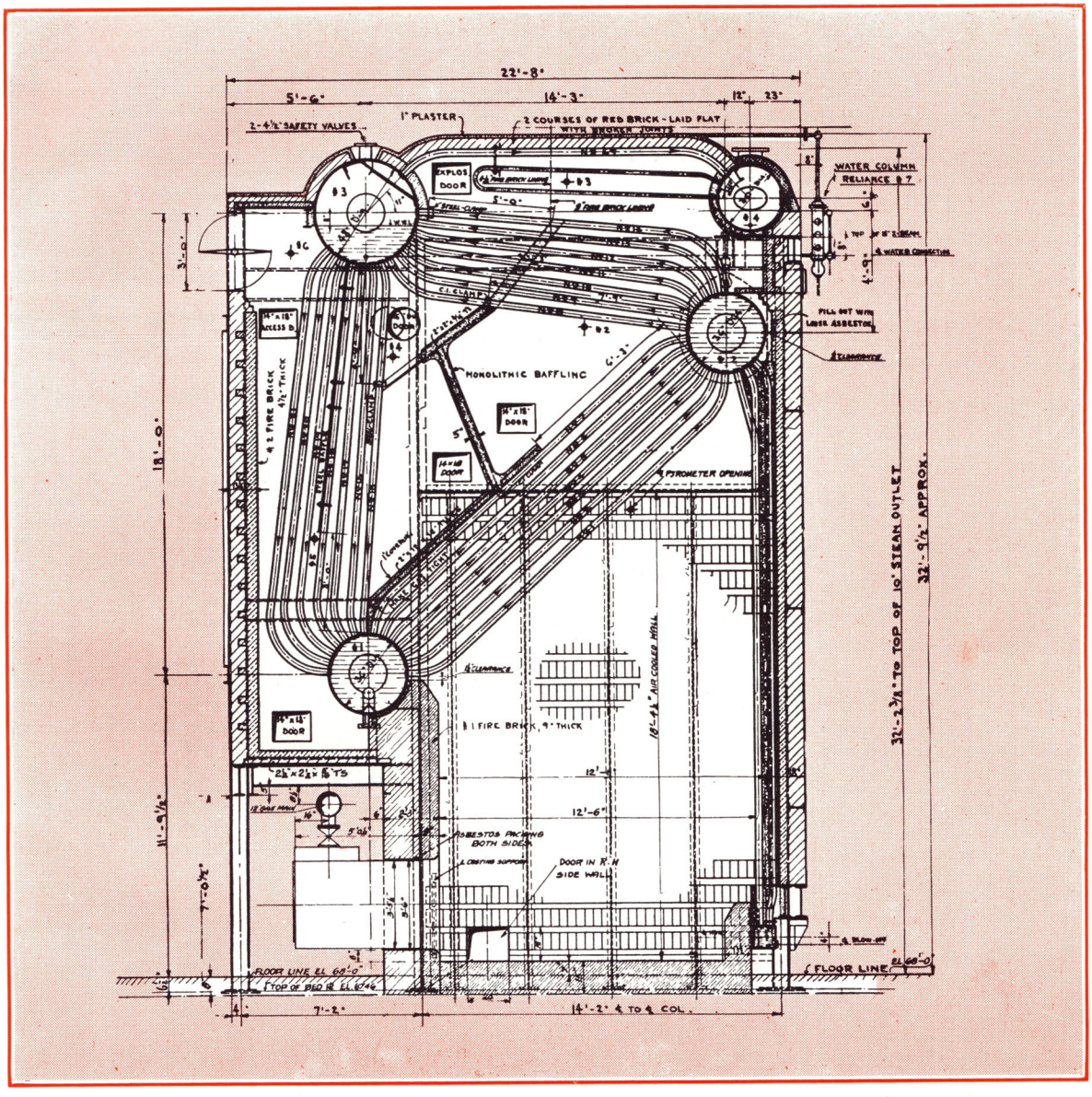
Fairmount Creamery Co., Cleveland, Ohio

Two—200 H.P. Riley-Badenhausen Boilers
Two—Jones Side Dump Stokers



Milcor Steel Co., Milwaukee, Wis.

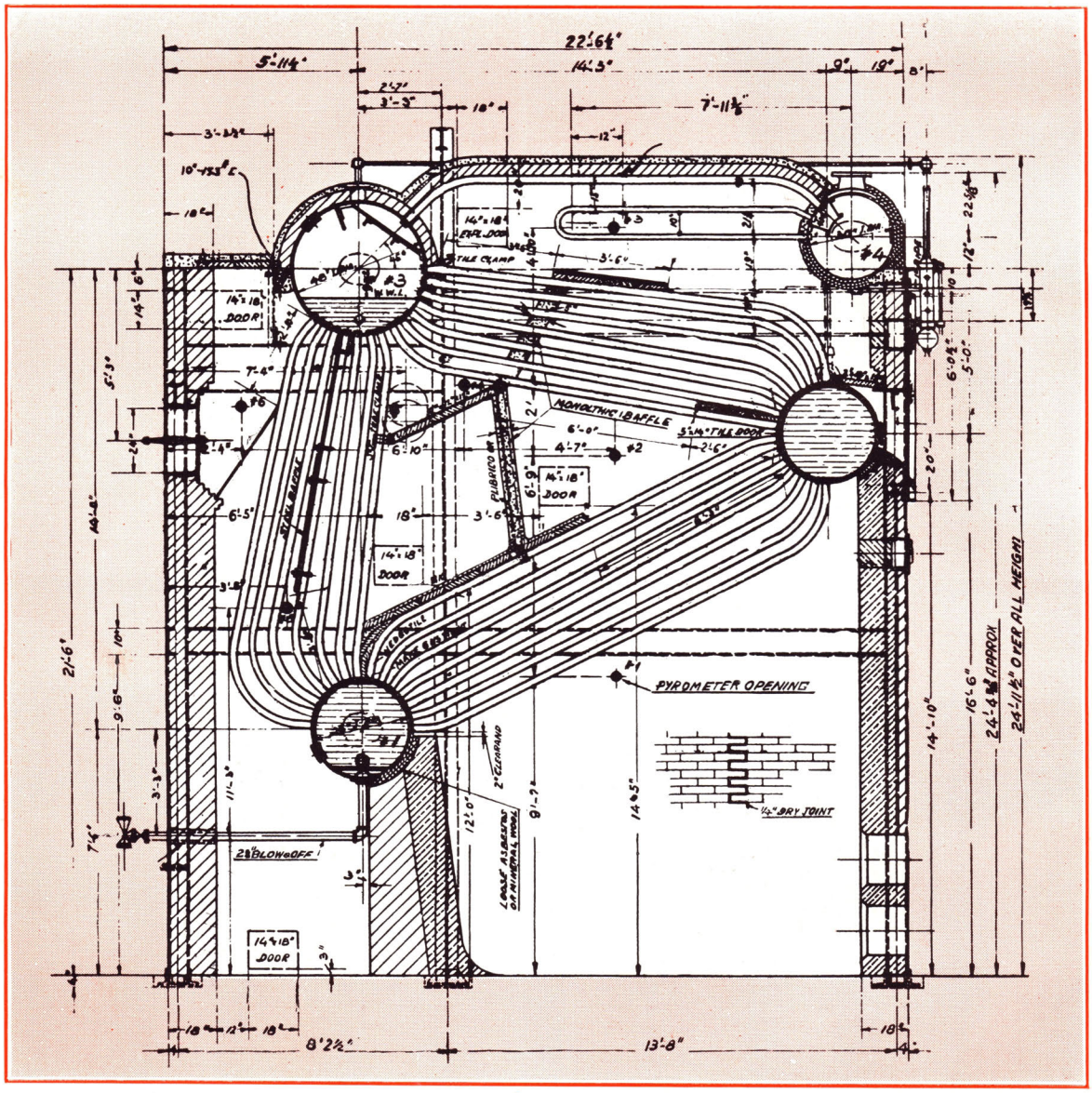
Three—250 H.P. Riley-Badenhausen Boilers and Superheaters
Three—Jones Side Dump Stokers



Brown Paper Mill Co., Inc., Monroe, La.

GEORGE F. HARDY, Consulting Engineer, New York, N. Y.

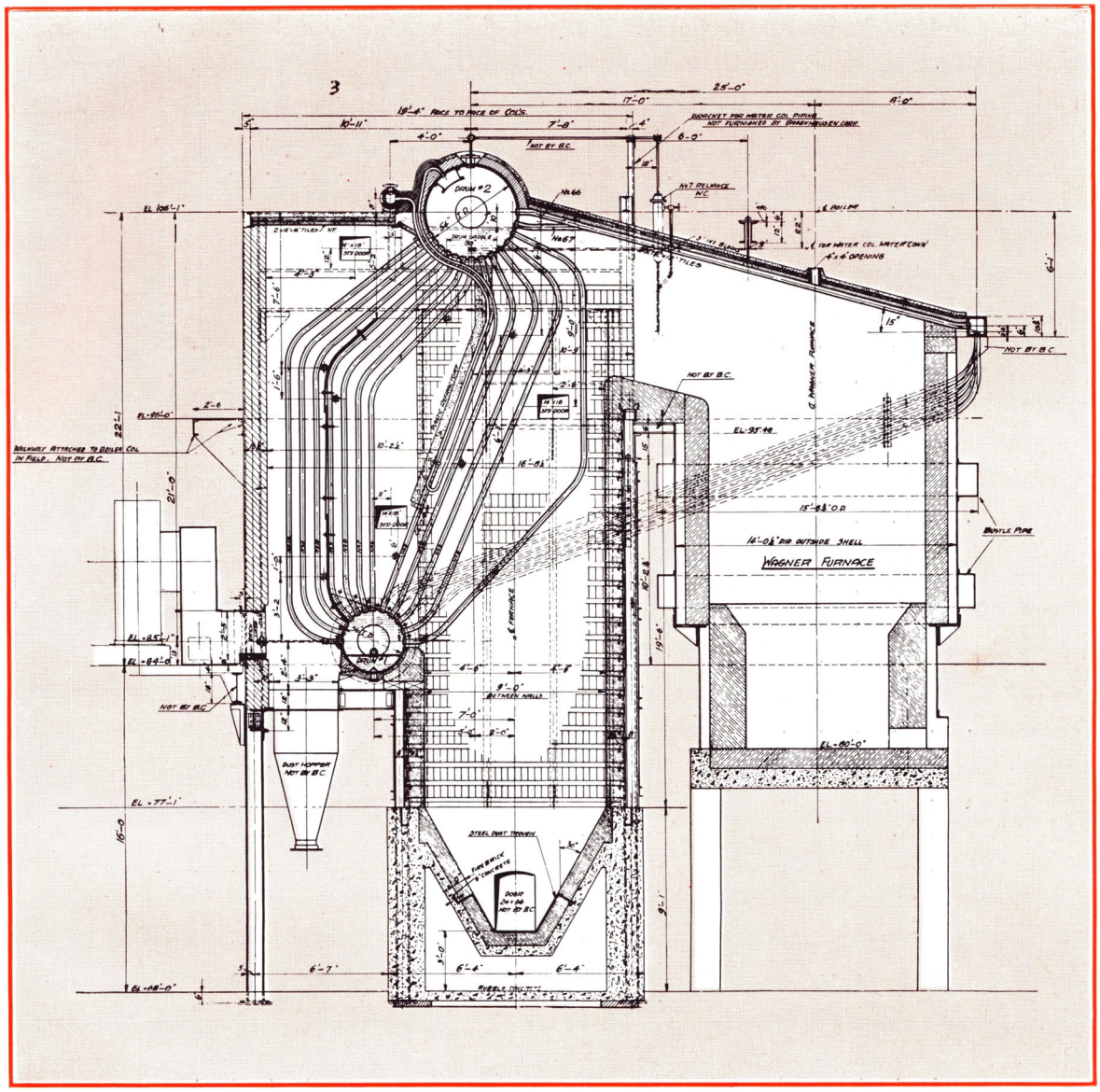
Eight—855 H.P. Riley-Badenhausen Boilers
These boilers are fired by natural gas.



Los Angeles Veterans' Home, Los Angeles, Calif.

Two—508 H.P. Riley-Badenhausen Boilers

These boilers are fired by oil.



Brown Paper Mills, Inc., W. Monroe, La.

GEORGE F. HARDY, Consulting Engineer, New York, N. Y.

Eight—400 H.P. Riley-Badenhausen Waste Heat Boilers

Partial List of Installations

Aberfoyle Manufacturing Co.	Chester, Pa.
Philip Carey Mfg. Co.	Plymouth Meeting, Pa.
Ford Motor Co.	Highland Park, Detroit, Mich.
Sunbury Converting Works	Belvidere, N. J.
Sunbury Converting Works	Sunbury, Pa.
Atwater Kent Manufacturing Co.	Philadelphia, Pa.
Central Paper Co.	Muskegon, Mich.
United States Pipe & Foundry Co.	Burlington, N. J.
United States Pipe & Foundry Co.	Scottdale, Pa.
United States Pipe & Foundry Co.	Birmingham, Ala.
Brown Paper Co.	Monroe, La.
Cyclops Steel Co.	Titusville, Pa.
Harnischfeger Corporation	Milwaukee, Wis.
Hoskins Morainville Co.	Menominee, Mich.
Franklin Heating Station	Rochester, Minn.
The Lang Co.	Gloucester, N. J.
Chicago & Northwestern Railway Co.	Chicago, Ill.
Otter Tail Power Co.	Jamestown, N. D.
Otter Tail Power Co.	Wahpeton, N. D.
Otter Tail Power Co.	Washburn, N. D.
DeLaval Steam Turbine Co.	Trenton, N. J.
Elliott Co.	Jeannette, Pa.
Lewis Jones, Inc.	Overbrook, Pa.
The Drake	Chicago, Ill.
Stirling Laundry	San Francisco, Calif.
Manz Corporation	Chicago, Ill.
Fraser Companies, Ltd.	Edmundston, N. B., Can.
Henry McCleary Lumber Co.	McCleary, Wash.
Arcadia Knitting Mills	Allentown, Pa.
Kieckhefer Container Co.	Delair, N. J.
Los Angeles Veterans' Home	Los Angeles, Calif.
Milcor Steel Co.	Milwaukee, Wis.
Lehigh Valley Coal Co.	Wilkes-Barre, Pa.
Northern Pacific Railway Co.	Brainard, Minn.
Northern Pacific Railway Co.	Glendive, Mont.
Cleveland Clinic	Cleveland, Ohio
Carnation Company	Waverly, Iowa
Northwestern Yeast Co.	Chicago, Ill.
Pacific Mills, Ltd.	Ocean Falls, B.C.
American Hair & Felt Co.	Chicago, Ill.
New Rosslyn Hotels,	Los Angeles, Calif.
Carpenter Steel Co.,	Reading, Pa.
Brehm & Stehle Co.	Philadelphia, Pa.
Fairmont Creamery Co.	Cleveland, Ohio
Seydel Chemical Co.	Jersey City, N. J.
Green Bay Sugar Refining Co.	Green Bay, Wis.
A. S. Kreider Co.	Pamyra, Pa.
Castle Kid Co.	Camden, N. J.
American Salpa Corporation	New York, N. Y.
Essex County Hospital	Cedar Grove, Pa.
Riverside Metal Co.	Riverside, N. J.
Harshaw, Fuller & Goodwin Co.	Philadelphia, Pa.
Sheip Co.	Philadelphia, Pa.
State of Nebraska	Grand Island, Neb.
Kindel Bedding & Renovating Co.	Johnstown, Colo.
Prest-O-Lite Co.	Indianapolis, Ind.
Pottsville Steam, Heat & Power Co.	Pottsville, Pa.
Longacre Park Heating Co.	Yeadon, Pa.
Christian Feigenspan Inc.	Albany, N. Y.
York Water Co.	York, Pa.
International Business Machines Co.	Endicott, N. Y.
Proctor & Schwartz, Inc.	Philadelphia, Pa.
Continental Can Co.	Jersey City, N. J.
Atlantic Mills	Providence, R. I
Imperial Laundry	Newark, N. J.
Barber Asphalt Co.	Maurer, N. J.
C. H. Wheeler Co.	Philadelphia, Pa.
Carus Chemical Co.	La Salle, Ill.
Galland Mercantile Laundry	San Francisco, Calif.
International Paper Co.	N. Tonawanda, N. Y.
Olive View Sanatorium	Olive View, Calif.
British Columbia Sugar Co.	Vancouver, B. C.
Calif. Co-operative Canneries	San Francisco, Calif.
City Hospital	Cleveland, Ohio
C. H. Masland & Sons Co.	Carlisle, Pa.
Publicker Commercial Alcohol Co.	Philadelphia, Pa.
State College	Brookings, S. D.
Joseph R. Foster & Sons	Philadelphia, Pa.
St. Croix Paper Co.	Woodland, Me.
Southern Paper Co.	Mosspoint, Miss.
Macalester College	St. Paul, Minn.
Pacific Colony	Opadra, Calif.
County of Los Angeles	Los Angeles, Calif.
Continental Diamond Fibre Co.	Wilmington, Del.

THE DAVIS PRESS WORCESTER MASS. U.S.A.

THE MANUFACTURE OF

RILEY-BADENHAUSEN

STEAM GENERATING EQUIPMENT

RILEY STOKER CORPORATION

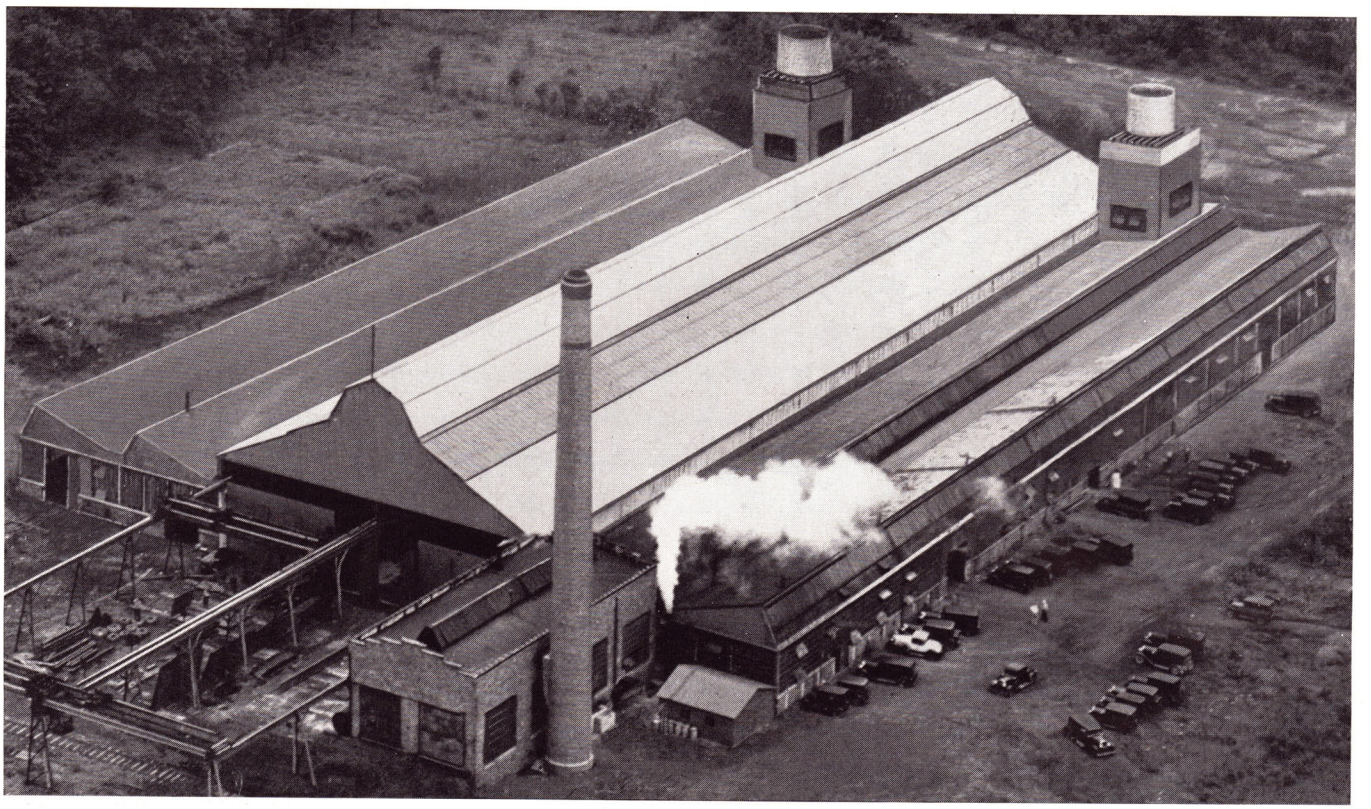
WORCESTER, MASS.

BOSTON NEW YORK PHILADELPHIA PITTSBURGH BUFFALO CLEVELAND DETROIT TACOMA ST LOUIS CINCINNATI HOUSTON
CHICAGO ST PAUL KANSAS CITY LOS ANGELES JACKSON, MISS. DENVER CHARLOTTE EL PASO SALT LAKE CITY NEW ORLEANS

RILEY ENGINEERING AND SUPPLY CO., LTD., TORONTO

Riley Stoker Co., Ltd., London
Fama—France, Italy, Holland, Belgium, Switzerland, Jugo-Slavia
International Machinery Co., (W. R. Grace Co.,) South America
Feuerungsanlagen Aktiengesellschaft, Germany
Andersen-Meyer & Co., China
American Trading Co., Japan

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS
AIR HEATERS • ECONOMIZERS • WATER-COOLED FURNACES

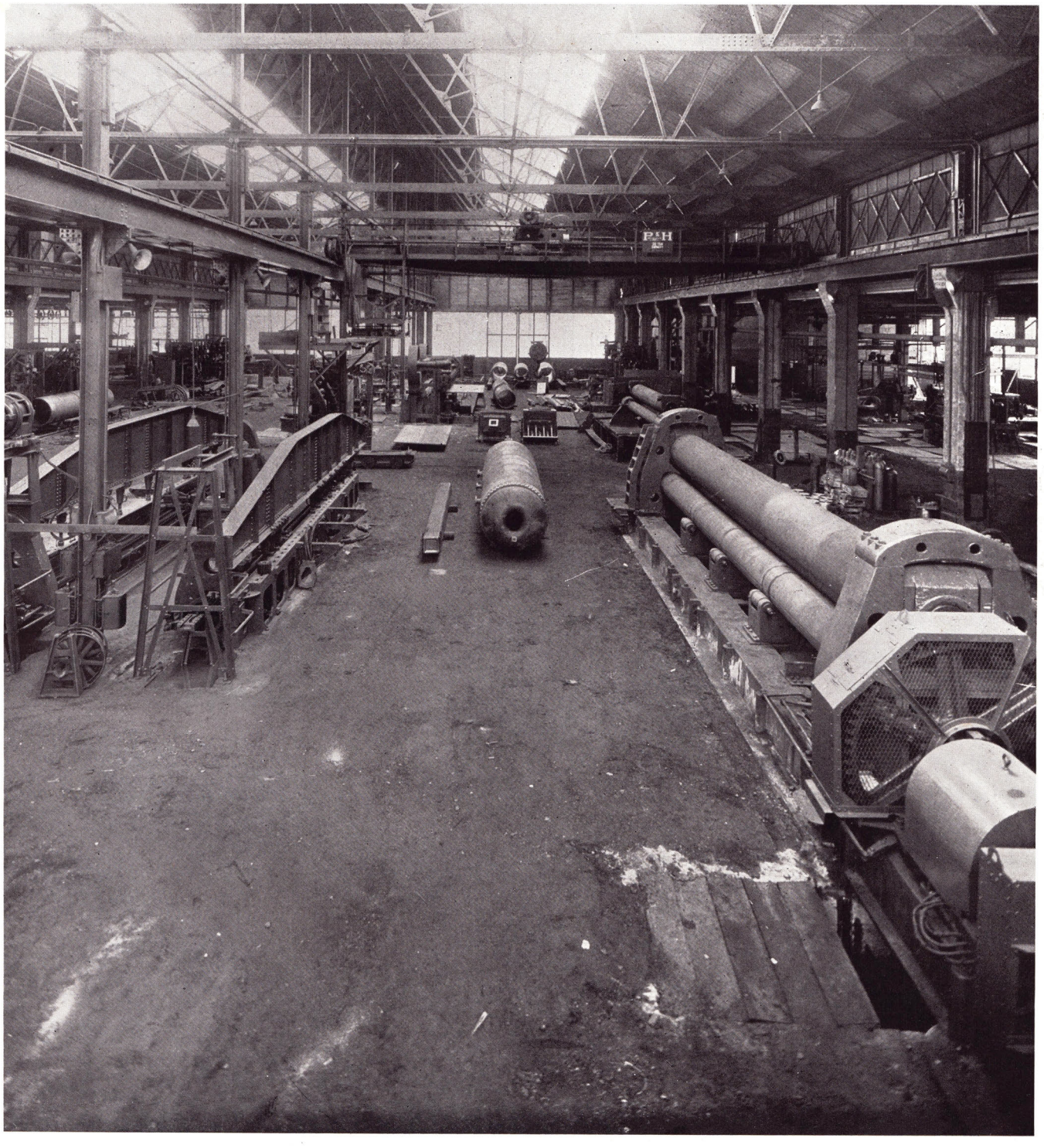


Aeroplane view of Cornwells Heights, Pa., Plant

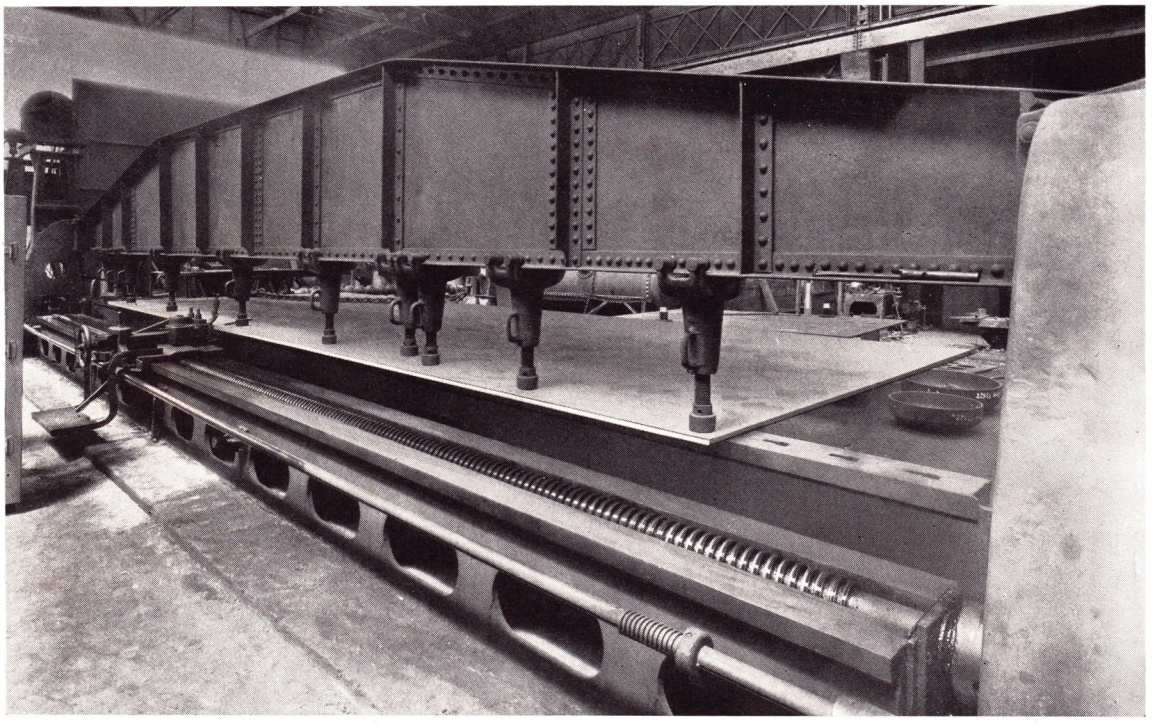
Manufacturing Riley-Badenhausen Steam Generating Equipment

With the complete facilities and machinery available in the modern plant shown above, and on the opposite page, the Riley Stoker Corporation is well equipped to build boilers and heat recovery apparatus to fully meet the highest standards of manufacturing practice.

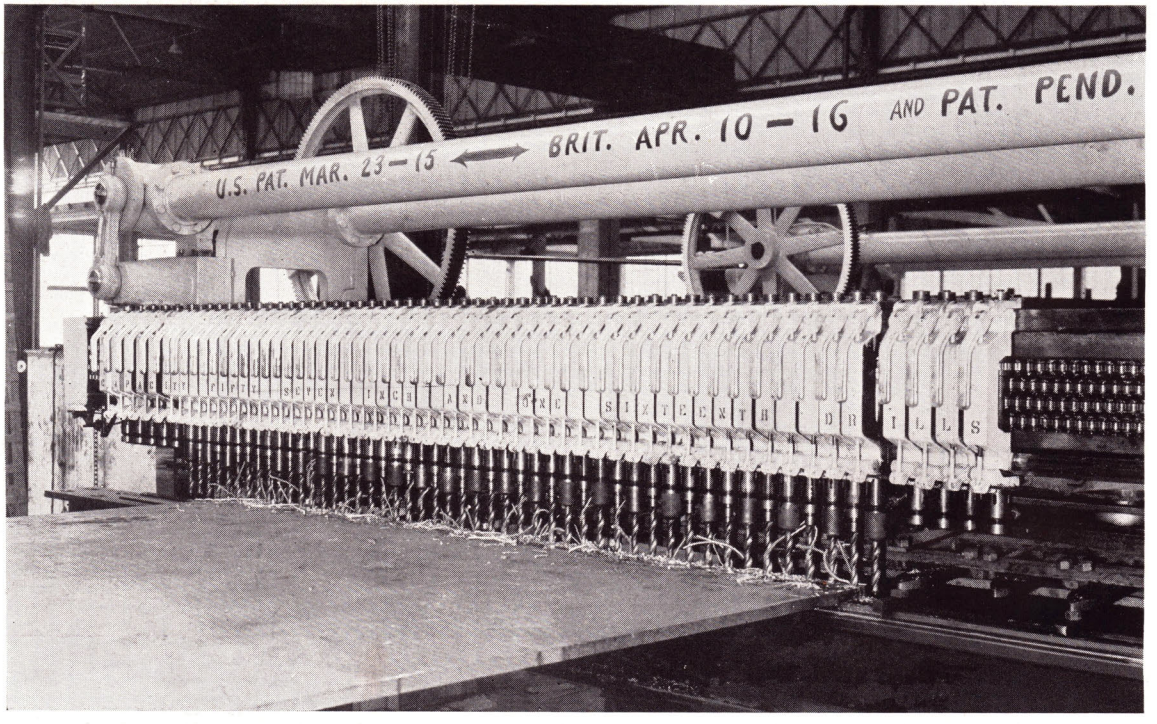
The following pages briefly illustrate a few of the major operations in the manufacture of Riley-Badenhausen Steam Generating Equipment.



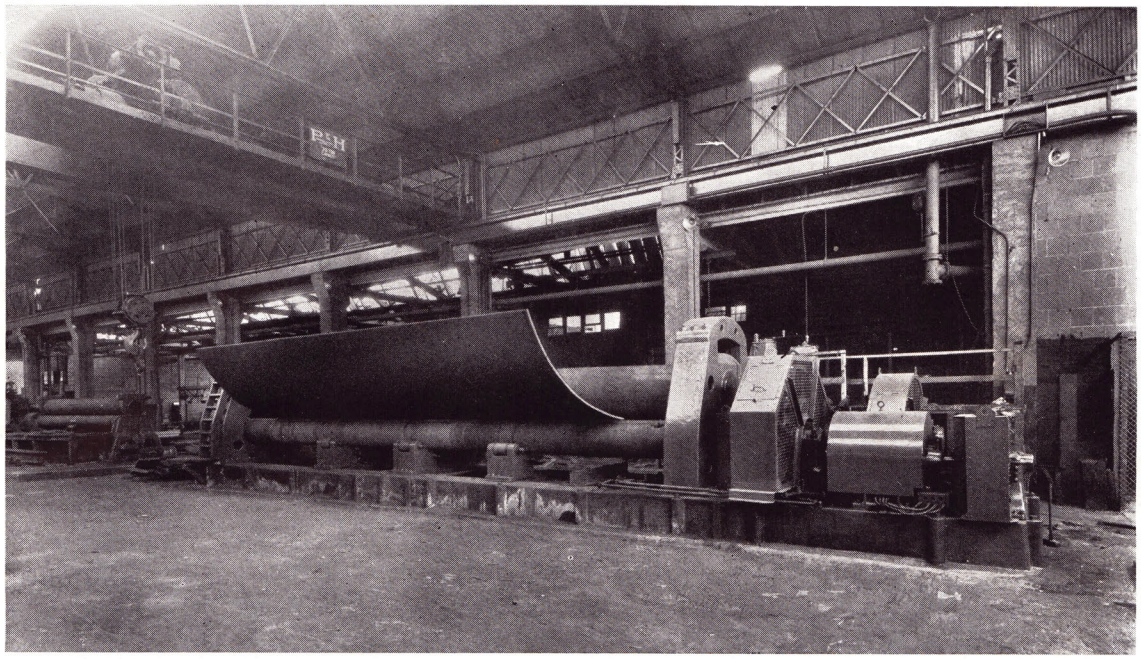
Interior of drum shop. Excellent lighting is obtained through glass roof and sides. This shop is served by four heavy duty cranes. Note large roll and planers.



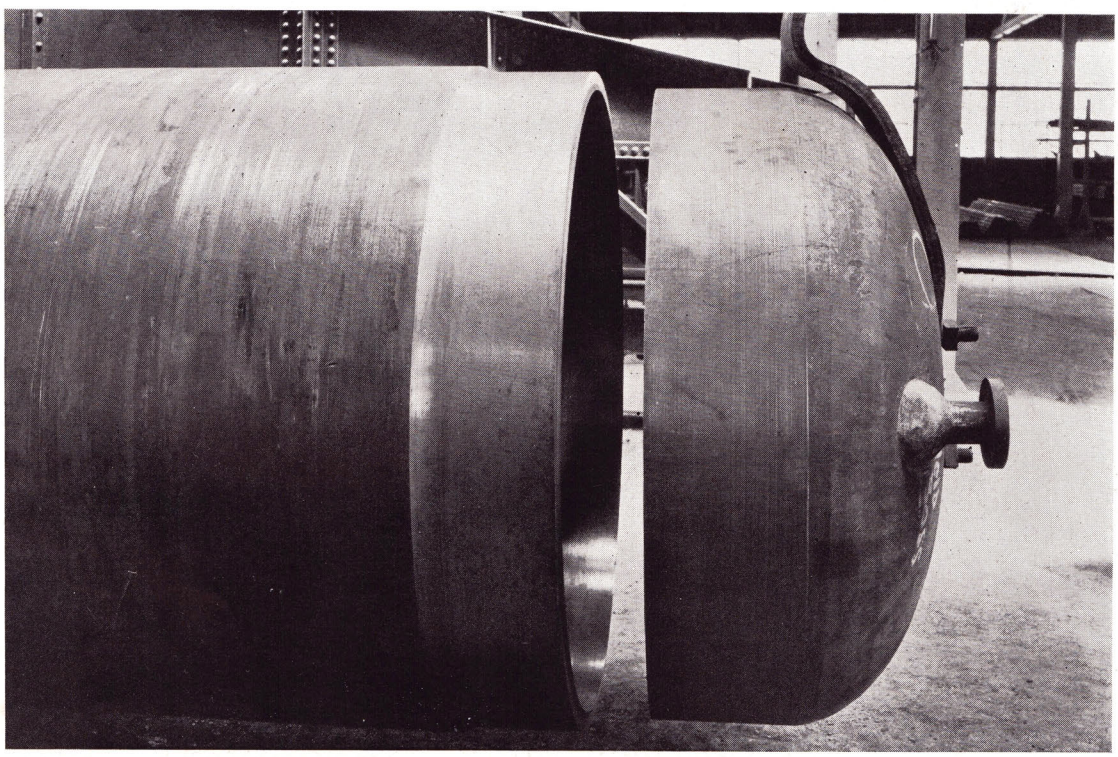
After a drum plate is laid out, the edges are planed. Each of the two planers is capable of planing plates 35 feet long.



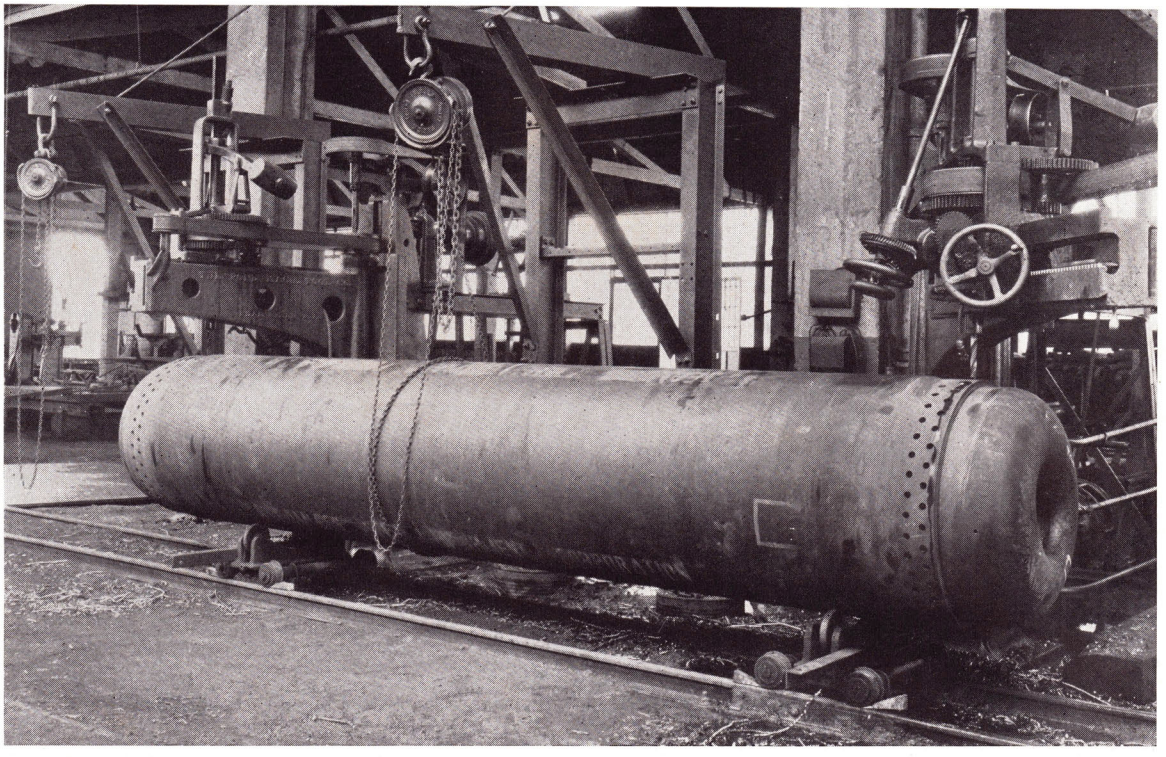
After the plate is planed, the end rivet holes are drilled undersize in the flat sheet. These ends when the plate is rolled receive the drum heads.



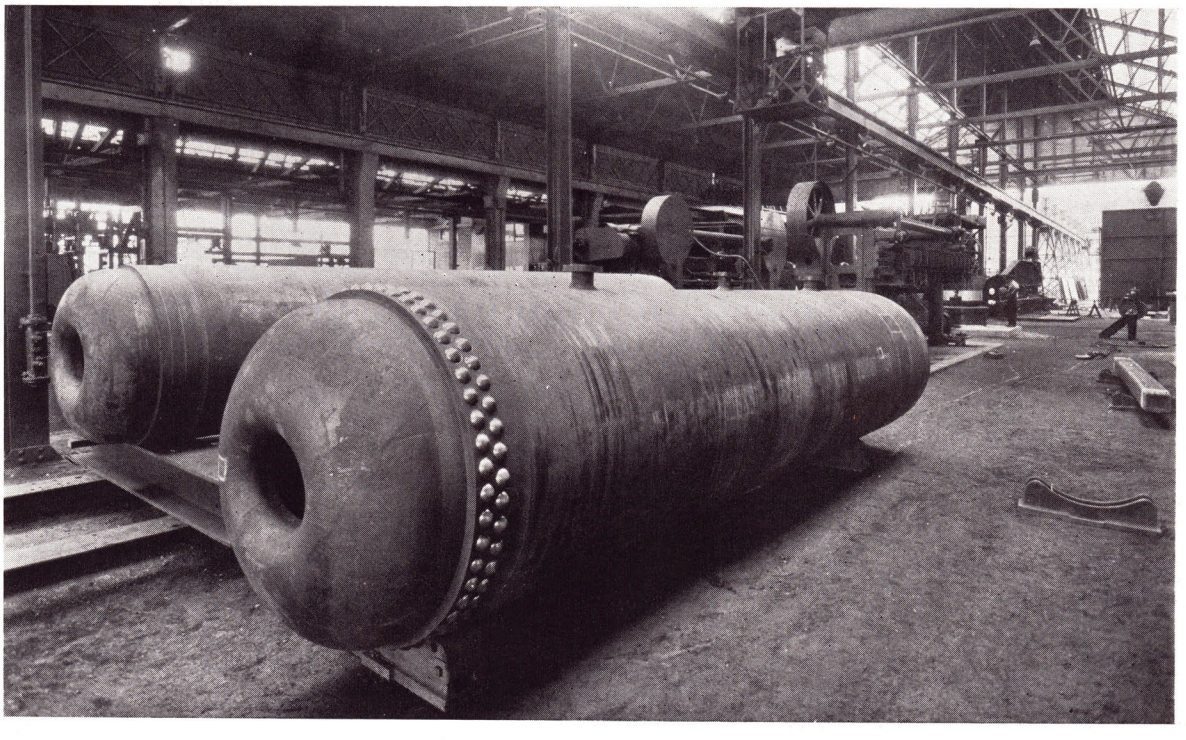
Large rolls used in rolling drum shells. These rolls are 34 feet, 6 inches between housings. The top roll is 33 inches in diameter.



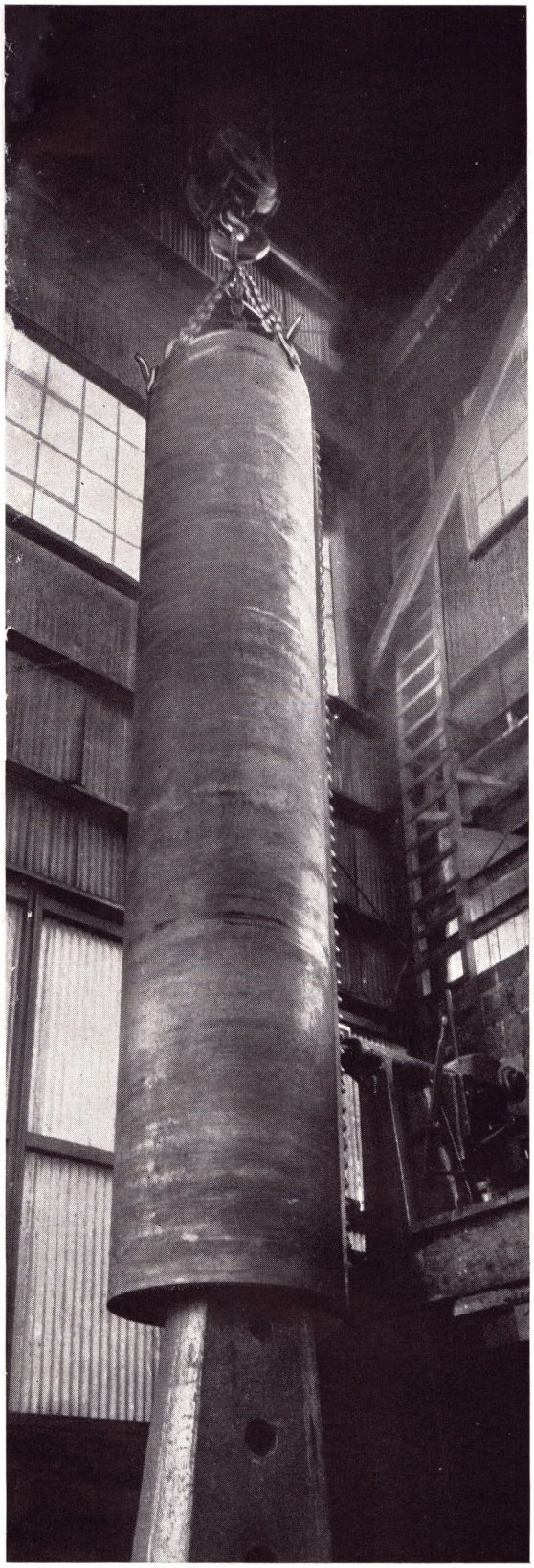
Drum shells are machined at the ends on the inside to receive the drum heads. The drum heads are machined on the outside to insure perfect metal to metal contact before the rivets are driven.

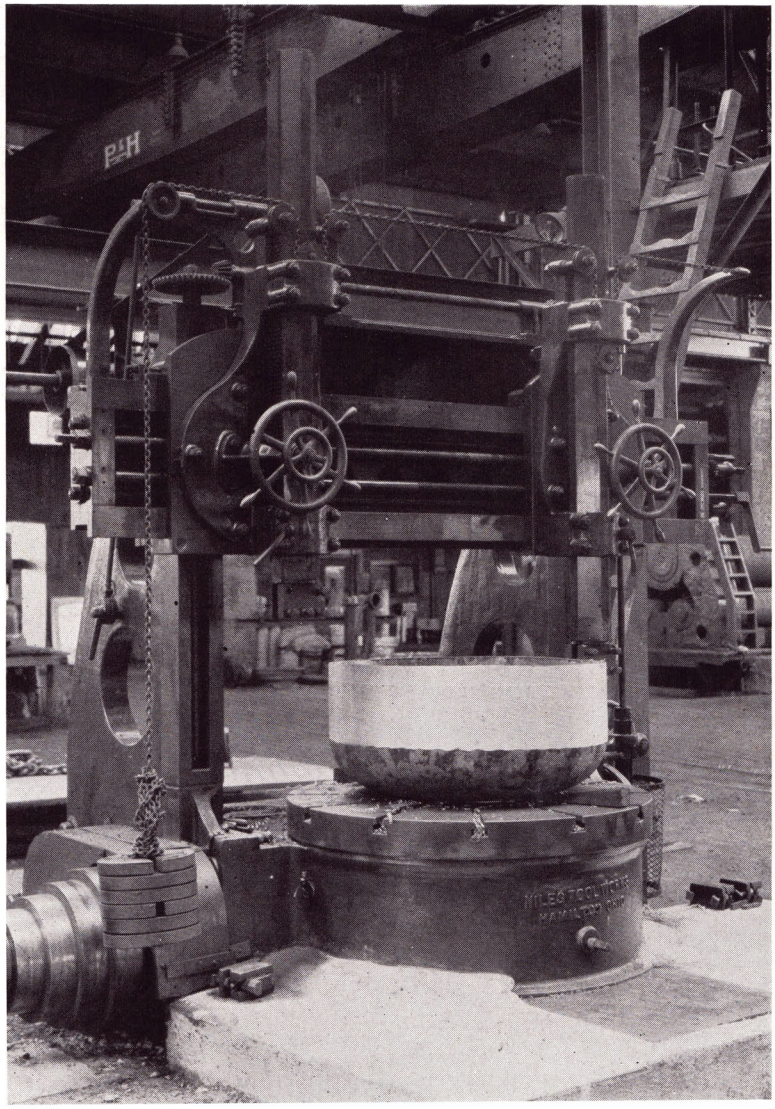


After the drum heads are inserted the rivet holes are drilled full size through drum shell and head.



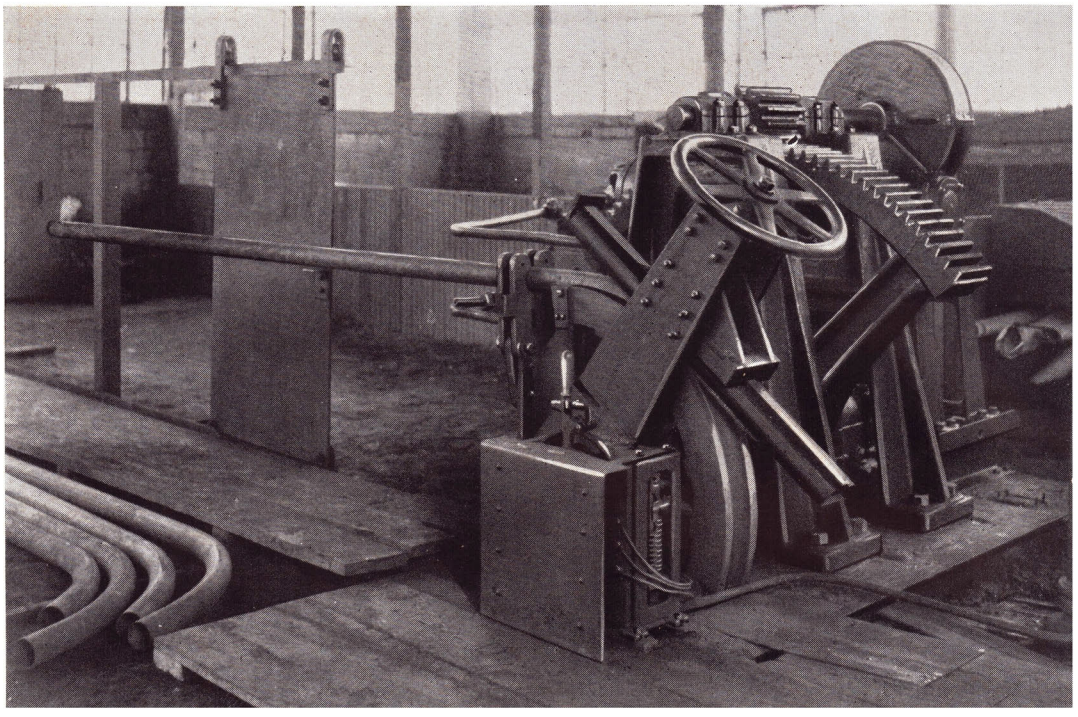
Following the riveting and caulking operations, the drums are hydraulically tested, after which the tube holes are drilled.



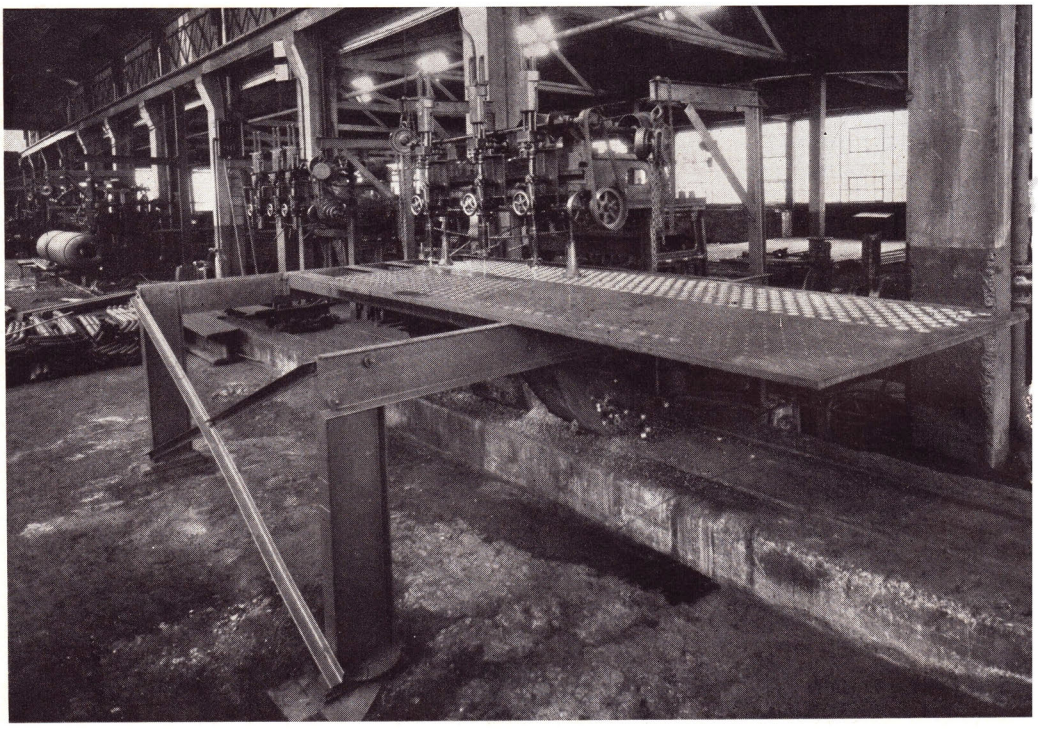


Upper view shows machining of drum head.

The view to the left shows a drum shell being riveted on the bull riveter.



Boiler tubes are accurately bent in the specially designed machine shown above



Drilling tube sheet for Riley-Badenhausen Tubular Air Preheater.